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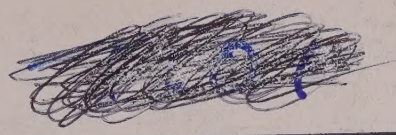
Dept 105 TO181

REGULATED D.C. POWER SUPPLIES



PE 1505/00 7.5 V 40 A

PE 1515/00 30 V 12.5 A

DEPT. 105

9499 155 00301

731015

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SERVICE MANUAL

# DEPT. 105

REGULATED D.C. POWER SUPPLIES

**PE 1505/00** 7.5 V 40 A

9416 015 05001

**PE 1515/00** 30 V 12.5 A

9416 015 15001

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Caution: If a switched-on apparatus is opened, pay attention to the fact that parts of the circuit has a mains voltage with respect to earth. These parts are marked red.

Warnung: Beim Öffnen eines eingeschalteten Gerätes ist zu beachten, dass Teile der Schaltung gegenüber Erde Netzspannung führen. Diese Teile sind rot markiert.

Attention: Si l'appareil enclenché est ouvert, ne pas oublier qu'une partie du circuit présente un tension secteur par rapport à la terre. Ces parties sont marquées en rouge.

# I. GENERAL

## A. INTRODUCTION

The stabilizer is intended for supplying electrical and electronic circuits.
The apparatus supplies, at option:

PE 1505 - a stabilized direct voltage of 0 ... 7.5 V
- a stabilized direct current of 0 ... 40 A

PE 1515 - a stabilized direct voltage of 0 ... 30 V
- a stabilized direct current of 0 ... 12.5 A

The apparatus is suitable for:

- remote sensing
- remote voltage- or current-programming
- series or parallel connection according to the "master and slave" system
- parallel connection of the over-voltage protection (crowbar) when stabilizers are connected in parallel.

## B. TECHNICAL DATA

### 1. General

| | |
|---|---|
| Mains voltage | : 220 V, 50 ... 60 Hz |
| Maximum current | : 3.0 A (PE 1505)<br>3.3 A (PE 1515) |
| Power consumption | : max. 600 VA (PE 1505)<br>max. 660 VA (PE 1515) |
| Mains fuses | : 2 fuses VL1 and VL2, each 6.3 A action delayed. |
| Mains switch | : 2-pole. |
| Indication | : - In case of voltage stabilization lamp "U" is lit.<br>- In case of current stabilization lamp "I" is lit.<br>- In case of over-voltage lamp "DC FAILURE" is lit.<br>- Volt- and ammeter switchable with buttons:<br>7.5 V, 15 A and 40 V (PE 1505)<br>12.5 V, 30 V and 12.5 A (PE 1515) |
| Protections | : - An over-voltage protection (crowbar) adjustable between:<br>3.5 and 10 V (PE 1505)<br>3.5 and 35 V (PE 1515)<br>- Fuse in the primary of the converter transformer VL26,<br>3.15 A very fast action. |
| Ambient temperature | : Minimum 0 °C, maximum 40 °C. |
| Cooling | : Normal air circulation, which may not be obstructed. |
| Design | : - As table model with cabinet PE 1392.<br>- For 19 inch rack mounting with adaptor PE 1391.<br>2 stabilizers can be mounted with PE 1391. |

| | |
|---|---|
| Dimensions | |
| - as table model | : Height 147 mm<br>Width 235 mm<br>Depth 404 mm |
| - when rack-mounted (without feet, but with mounting brackets) | : Height 133 mm<br>Width 209 mm<br>Depth 416 mm |
| Weight | : Net. 9.7 kg |

## 2. Output PE 1505

### a. As voltage stabilizer

| | |
|---|---|
| Voltage | : - 0 ... 7.5 V continuously adjustable.<br>- Resolution $\leq$ 5 mV. |
| Series connection | : - 3 apparatus max.<br>- The voltage between any one of the output terminals and earth may not exceed 90 V ⎓<br>- For series connection according to "master and slave" system see chapter III item B.5. |
| Current | : 40 A max. for each value of the output voltage. |
| Parallel connection | : - Any number, provided the over-voltage protections are also parallel-connected (connect terminal 10 mutually).<br>- For parallel connection according to "master and slave" system see chapter III item B.6. |
| Stability | : For mains voltage variations of +10 % of the rated value, the fluctuation of the output voltage is $\leq$ 0.03 % of the set value or $\leq$ 1 mV.<br>Whichever is greater applies. |
| Internal resistance | : Static: $\leq$ 0.5 mΩ for slow changes from no load to full load.<br>Dynamic: For sinusoidal load variations from 80 % of full load up to full load and a frequency of:<br>0.1 kHz $\leq$ 15 mΩ<br>0.5 kHz $\leq$ 30 mΩ<br>1 kHz $\leq$ 20 mΩ<br>10 kHz $\leq$ 20 mΩ<br>100 kHz $\leq$ 20 mΩ<br>250 kHz $\leq$ 30 mΩ |
| Recovery time | : $\leq$ 100 msec. for square-wave load variations from 80 to 100 % (see Fig. 9). |
| Ripple voltage | : $\leq$ 5 $mV_{r.m.s.}$ |
| Temperature coefficient | : $\leq$ 0.01 % or $\leq$ 0.5 mV per °C of the set value of the output voltage between 0 and 7.5 V in the range of 0 ... 40 °C.<br>Whichever is greater applies. |

b. As current stabilizer

Current : - 0 ... 40 A continuously adjustable.
- Resolution $\leq$ 40 mA.

Stability : - For mains voltage variations of $\pm$10 % of the rated value, the fluctuation of the output current is $\leq$ 0.01 % of the set value or $\leq$ 15 mA.
Whichever is greater applies.
- At a load variation from point E to point G (see Fig. 7) the fluctuation of the output current is $\leq$ 40 mA of the set value.

Ripple current : $\leq$ 130 $mA_{r.m.s.}$

Temperature coefficient : $\leq$ 0.05 % or $\leq$ 5 mA per $^{o}C$ of the set value of the output current between 0 and 40 A in the range of 0 ... 40 $^{o}C$. Whichever is greater applies.

Cross-over point (see Fig. 7) : - Point C-D < 650 mA. This value applies for any set output current between 0 and 40 A.
- Point D-E < 15 mV. This value applies for any set output voltage between 0 and 7.5 V.

3. Output PE 1515

a. As voltage stabilizer

Voltage : - 0 ... 30 V continuously adjustable.
- Resolution $\leq$ 20 mV.

Series connection : - 3 apparatus max.
- The voltage between any one of the output terminals and earth may not exceed 90 V ⎓
- For series connection according to "master and slave" system see chapter III item B.5.

Current : 12.5 A max. for each value of the output voltage.

Parallel connection : - Any number, provided the over-voltage protections are also parallel-connected (connect terminal 10 mutually).
- For parallel connection according to "master and slave" see chapter III item B.6.

Stability : For mains voltage variations of $\pm$10 % of the rated value, the fluctuation of the output voltage is $\leq$ 0.03 % of the set value or $\leq$ 1 mV.
Whichever is greater applies.

Internal resistance : Static: $\leq$ 2 mΩ for slow changes from no load to full load.
Dynamic: For sinusoidal load variations from 80 % of full load up to full load and a frequency of:

| | |
|---|---|
| 0.1 kHz | $\leq$ 30 mΩ |
| 0.5 kHz | $\leq$ 90 mΩ |
| 1 kHz | $\leq$ 50 mΩ |
| 10 kHz | $\leq$ 30 mΩ |
| 100 kHz | $\leq$ 30 mΩ |
| 250 kHz | $\leq$ 50 mΩ |

Recovery time : $\leq$ 100 msec. for square-wave load variations from 80 to 100 % (see Fig. 9).

Ripple voltage : $\leq$ 3 $mV_{r.m.s.}$

Temperature coefficient : $\leq$ 0.01 % or $\leq$ 1 mV per °C of the set value of the output voltage between 0 and 30 V in the range of 0 ... 40 °C. Whichever is greater applies.

b. As current stabilizer

Current : - 0 ... 12.5 A continuously adjustable.
- Resolution $\leq$ 15 mA.

Stability : - For mains voltage variations of ±10 % of the rated value, the fluctuation of the output current is $\leq$ 0.01 % of the set value or $\leq$ 5 mA. Whichever is greater applies.
- At a load variation from point E to point G (see Fig. 8) the fluctuation of the output current is $\leq$ 12 mA of the set value.

Ripple current : $\leq$ 40 $mA_{r.m.s.}$

Temperature coefficient : $\leq$ 0.05 % or $\leq$ 1.5 mA per °C of the set value of the output current between 0 and 12.5 A in the range of 0 ... 40 °C. Whichever is greater applies.

Cross-over point (see Fig. 8) : - Point C-D < 40 mA. This value applies for any set output current between 0 and 12.5 A.
- Point D-E < 40 mV. This value applies for any set output voltage between 0 and 30 V.

## II. DESCRIPTION

### A. PRINCIPLE OF OPERATION

1. Purpose

The intention is to reduce the dimensions of the instrument with respect to other supply instruments, in which conventional techniques are applied.
The primary circuit is therefore switched with a frequency of 20 kHz by means of two switching transistors, so that the large and heavy 50 Hz-transformer can be omitted and replaced by a smaller 20 kHz-transformer with ferroxcube core. The dimensions of the smoothing filter will also be smaller. Furthermore, the output will be increased, because no dissipating series regulator has been applied.

2. Working (Fig. 1 and 2)

The mains voltage is rectified by GR1 and smoothed by filter choke L1 and capacitor C1.
This rectified voltage is supplied to the convertor which consists of transformer T1 and switching transistors TS1 and TS2.

Square-wave voltages with a frequency of 20 kHz are applied to the bases of TS1 and TS2; they are phase-shifted by 180° with respect to each other and their pulse width is adjustable. So the d.c. voltage supplied to the convertor is converted to an a.c. voltage of 20 kHz, which is again rectified by GR2 and smoothed by filter chokes L2 and L3 and capacitor C2, after which it is supplied to the output terminals via a shunt.
The output voltage is now adjusted by varying the pulse width. Pay attention that the maximum pulse width remains smaller than T/2, otherwise both transistors (TS1 and TS2) become conductive. In this case a high dissipation appears in the transistors that they blow immediately.
The pulse width is adjusted by comparing two sawtooth voltages phase-shifted by 180° (Z1 and Z2) with a control voltage $V_s$ (Fig. 2).
Take care that $V_s$ does not become smaller than $V_{s\ min.}$, so that the maximum pulse width is limited to a value smaller than T/2.
Fig. 2. shows that, when both transistors TS1 and TS2 are not conductive, $V_{CE1}$ and $V_{CE2}$ are equal to $V_{C1}$. If a pulse is supplied to the base of TS1 or TS2 so that the relevant transistor becomes conductive, $V_{CE}$ across the other transistor will equal twice $V_{C1}$.
The control voltage $V_s$ can be adjusted by means of 3 different circuits.

a. Voltage stabilization

The output voltage $V_{out}$ is compared with a reference voltage by means of a comparator. The resulting difference voltage is amplified and supplied as control voltage $V_s$ to the pulse-width regulator.
If $V_{out}$ increases, $V_s$ increases and the pulse width decreases (Fig. 2), so that $V_{out}$ decreases to its original value.
If $V_{out}$ decreases, the opposite happens.

b. Current stabilization

For current stabilization the voltage across the shunt (R1) due to the output current is compared with a reference voltage. Adjusting is performed in the same way as for voltage stabilization.

c. Switch-on delay

The switch-on delay makes it possible to start with a minimum pulse width, after which it increases slowly up to the value required. This prevents overload of the switching transistors.

## B. DIAGRAM (Fig. 13 and 14)

### 1. Rectifier circuit

The mains voltage is directly full-wave rectified by a Grätz circuit, which consists of diodes GR26, 27, 28 and 29. The rectified voltage is smoothed by filter L26/C27 and supplied to the convertor circuit (transformer T26 and switching transistors TS29 and 31) via fast-blow fuse VL26.
As square-wave voltages are supplied to the bases of TS29 and 31 (phase-shifted by 180°) at a frequency of 20 kHz, the rectified mains voltage is converted to a lower a.c. voltage at the secondary side of T26. This a.c. voltage is again rectified by diodes GR31 and 32 and smoothed by filter L27/C29/L28; then it is supplied to the output terminals via shunt R29.

### 2. Auxiliary voltages

Transformer T31 delivers the auxiliary voltages for the adjusting amplifiers and the various check circuits.
The a.c. voltage of coil S2 (A and B) is full-wave rectified by a Grätz circuit (GR34), which results in a d.c. voltage of + and -6.5 V.
The a.c. voltage of coil S3 is rectified by GR42, which results in a d.c. voltage of 90 V and is used for indicator lamps LA1 and LA2.

The a.c. voltage of coil S4 (A and B) is full-wave rectified by GR44, which results in a d.c. voltage of + and -20 V. With the voltage of -20 V a stabilized voltage of -15 V is obtained with the aid of transistors TS37, 38 and 39, and which can be adjusted by means of resistor R77.
With the voltage of +20 V a stabilized voltage of +15 V is obtained with the aid of transistors TS43 and 44. As reference voltage serves the with R77 adjusted voltage of-15 V.

3. Sawtooth generator

The sawtooth generator consists of astable multivibrator TS46 and 47 with capacitors C48 and 54 at the outputs.
When transistor TS46 is conductive, C48 can be discharged. At the same time transistor TS47 is blocked and capacitor C54 can be charged via R98.
The next moment TS46 is blocked and C48 can be charged via R97; TS47 then becomes conductive so that C54 is discharged. The frequency is 20 kHz. In this way two sawtooth voltage phase-shifted by 180° are obtained.
With R95 both voltages are made symmetrical.
The circuit consisting of transformer T27, potentiometer R91 and resistor R103, serves to compensate the ripple. The ripple is adjusted to a minimum value by means of R91.

4. Control circuit

The control circuit consists of:

a. Pulse width controller
b. Control transistors TS29 and 31.

a. Pulse width controller

The pulse width controller consists of a long tail pair; at one side double transistor TS48-1 and 2 and at the other side TS51, while TS49 works as a current source.
A sawtooth voltage from C54 is supplied to the base of TS48-1 and another from C48 to the base of TS48-2. The adjustable control voltage $V_s$ is supplied to the base of TS51.
If the voltage at the base of TS51 is higher than the highest instantaneous value of the sawtooth voltages at the bases of TS48-1 and 2, TS51 becomes conductive and TS48-1 and 2 are blocked, so that no pulse voltages appear at the collectors of TS48-1 and 2. If, however, voltage $V_s$ becomes lower than the highest instantaneous value of the sawtooth voltages, narrow pulses appear at the collectors of TS48-1 and TS48-2. These pulses become wider according as $V_s$ becomes lower (see Fig. 2). The pulse width can thus be varied by adjusting voltage $V_s$.

The control voltage can be supplied via:
- GR56 of the switch-on delay,
- GR69 of the voltage stabilizer,
- TS54 of the current stabilizer,
- GR68 of the clamping circuit, which takes care that the maximum pulse width is always smaller than T/2.
  The clamping circuit consists of GR70, R112 and R115.

The square-wave voltage at the collector of TS48-1 is supplied to pulse transformer TS28 via GR62 and 61 and TS52. In the same way, the square-voltage at the collector of TS48-2 is supplied to pulse transformer T29 via GR66 and 67 and TS53.
In order to prevent saturation of TS52 diodes GR61, 62 and 63 are mounted.
For TS53, use is made of diodes GR64, 66 and 67.

b. Control transistors TS29 and TS31

The square-wave voltage at coil S2 of pulse transformer T28 opens and closes switching transistor TS27. As TS27 is connected to the base of switching transistor TS29 of the converter circuit, the required square-wave voltage is supplied to the base.

If the square-wave voltage disappears at the base, $V_{CE}$ increases already while $I_C$ has not entirely disappeared, as a result of the storage time. Switching transistor TS29 then becomes defective as a result of too a high dissipation.
In order to let $V_{CE}$ increase slowly, resistor R41 and capacitor C36 are mounted. In order to reduce the storage time and thus to make $I_C$ rapidly 0, the base of TS29 is negatively controlled after the square-wave voltage has disappeared. This is performed with transistor TS28, which is controlled by the square-wave voltage from coil S3 of pulse transformer T28 (see the direction of winding on the diagram).
The same happens with switching transistor TS31, but phase-shifted by 180°.

5. Switch-on delay

As switching-on the instrument does not operate the various control circuits immediately, various parts might become defective. In order to prevent this, a switch-on delay has been mounted.
It is also operated if the mains voltage becomes lower than a certain value or if the crowbar is switched-on, or if the instrument is switched-off and immediately switched-on again.
At switching-on capacitor C57 is not yet charged, so that a voltage $V_s$ appears via GR56 at the base of TS51, which voltage is higher than the instantaneous value of the sawtooth voltages at TS48-1 and 2. No square-wave voltages are then supplied. At the same time of switching-on transistor TS36 becomes conductive (depending on the position of R71 and the value of the mains voltage) and TS34 is blocked. TS41 and TS42 are then also blocked. As a result of this C57 will now be charged, so that voltage $V_s$ at the base of TS51 decreases and the control circuit becomes active (see 4.a.).
Potentiometer R71 is adjusted in such a way that, when the mains voltage decreases below 180 V, TS36 becomes blocked. TS34 then becomes conductive as well as TS41 and TS42. C57 will then be discharged via TS42 and R82, so that $V_s$ increases and no more square-wave voltage are supplied.
If the mains voltage increases above 180 V, the switch-on delay is again operated.
If the instrument is switched-off and immediately switched-on again, C57 must be discharged rapidly, so that the switch-on delay is operated while switching-on. Therefore R71 is connected to +20 V via GR48 and R50.
As a result of the small capacitance of C33 (diode GR46 blocks C41) the voltage across R71 decreases immediately at switching-off and TS36 is blocked. TS42 then becomes conductive and C57 can be discharged. This is performed within 1/2 period. After that delayed switching-on is again possible.

6. Voltage stabilization

At the input of amplifier IC27 the output voltage is compared with a reference voltage. The voltage across resistor R147 is used as a reference.
This voltage is part of the voltage across zener diode GR77.
The reference voltage is adjusted to a fixed value with R151 by measuring a current of 2.5 mA between points A and B after adjusting.
The reference voltage is connected to point 2 of IC27.
The output voltage is connected to point 3 of IC27 by means of a voltage divider consisting of resistors R156, 153 and 154 and potentiometer R1 (terminals 6 and 7 of the terminal strip at the rear side of the instrument are interconnected).
R169 serves for remote sensing.
If the output voltage of the instrument increases, the voltage at point 3 of IC27 becomes positive with respect to the voltage at point 2, so that the output (point 6) becomes positive.
The output of IC27 is connected to TS51 via GR69. The control voltage at the base of TS51 then becomes higher so that the pulses from the pulse width controller become narrower. The output voltage then decreases to the adjusted value.
When the output voltage decreases, the opposite applies.
The output voltage is adjusted with R1 and the voltage range with R154.

7. Current stabilization

At the input of amplifier IC?6, the voltage across shunt R29 is compared with a reference voltage. The latter is part of the voltage across zener diode GR74 and is adjusted by means of R2. Via interconnected terminals 3 and 4 of the terminal strip at the rear of the instrument, the reference voltage is supplied to point 2 of IC26.
The voltage across shunt R29 is supplied to point 3 of IC26 by means of a voltage divider which consists of R138 and R139. R161 serves for remote sensing.
As long as, due to the output current, the voltage across R29 + R138 is lower than the reference voltage adjusted with R2, point 3 of IC26 is positive with respect to point 2, so that the output (point 6) becomes positive. Transistor TS54, which is connected to point 6 via R124, remains blocked, so that the voltage stabilizer adjusts the output voltage via GR69.
If the output current increases that much that the voltage across R29 + R138 becomes higher than the voltage adjusted with R2, point 3 of IC26 becomes negative with respect to point 2; the output then becomes negative. TS54 now becomes conductive and the control is taken over by this transistor. Control voltage $V_s$ at the base of TS51 is now delivered by the current stabilizer.
Voltage adjustment has now become current adjustment.
The current range is adjusted with R141.

8. Indication at current or voltage stabilization

During current stabilization TS57-1 is conductive and TS57-2 blocked.
TS56 and 58 are then also blocked. As a result of the voltage across C39, lamp LA2 (I) lights.
Lamp LA1 (U) is extinguished.
As soon as the current stabilization has become voltage stabilization, TS57-2 becomes conductive and thus TS56 and 58. Lamp LA1 (U) then lights. As a result of this and of the current across R54, the current across R53 increases, so that the voltage across C39 decreases and lamp LA2 (I) is extinguished.

9. Overvoltage protection (crowbar)

In normal operation TS59-1 is conductive and TS59-2 blocked. TS61 is then also blocked. No trigger voltages for thyristors TS62 and 63 are supplied.
They remain blocked. Lamp LA3 (DC FAILURE) is extinguished.
If the output voltage increases, TS59-2 can become conductive via R168, at a moment adjustable with R3 (OVERVOLTAGE PROTECTION). When TS59-2 becomes conductive, TS61 becomes also.
A trigger voltage is then supplied via voltage divider R171 and 172 to thyristor TS63 and another via voltage divider R166 and 167 to thyristor TS62, so that both thyristors are turned on.
Due to TS63 the output is then immediatement short-circuited.
As TS62 becomes conductive, transistor TS41 - and thus TS42 - becomes conductive via GR43 and R72. C57 can then be discharged, so that control voltage $V_s$ at the base of TS51 (via GR56) increases. Square-wave voltages are then no longer delivered from pulse width controller and the output voltage decays.
Lamp LA3 lights via GR43 and TS62.
Lamp LA1 (U) must then be extinguished.
If more stabilizers are parallel-connected and the crowbar of one of them is switched-on, the remaining stabilizers will all deliver maximum current. In order to prevent this, terminal 10 (terminal strip at the rear) of each instrument must be interconnected. Via TS62, which is conductive, transistors TS41 and 42 of the remaining stabilizers become conductive, so that the relevant capacitors C57 can be discharged. The output voltage in these stabilizers will then also decay.
As soon as the cause of overvoltage is eliminated, the output voltage is recovered by switching off and immediately on again the stabilizer.

# III. CONNECTIONS

## A. MAINS AND EARTH

### 1. Earth

The apparatus have to be earthed via the rim earth of the mains connector.
The circuit to be powered can be earthed via the earth terminal "⏚" at the rear.

### 2. Mains voltage

The stabilizer is only applicable at a mains voltage of 220 V, 50 ... 60 Hz.

> Caution: If a switched-on apparatus is opened, pay attention to the fact that parts of the circuit has a mains voltage with respect to earth. These parts are marked red.

## B. OUTPUT

Note: During operation it is not allowed to disconnect any wiring in the circuits described under items 2, 3, 4, 5 and 6.

### 1. Normal use

The output voltage is taken from terminals "+" and "-" at the rear of the apparatus.

Terminal 3 of the terminal strip must be interconnected with terminal 4 and terminal 6 with terminal 7 (see Fig. 10.a.).

### 2. Remote sensing

If the instruments to be connected are at a large distance from the stabilizer, the voltage loss in the leads to the load must be compensated for in order to prevent adjusting errors at the terminals of the load.
The + terminal of the load must then be connected to terminal 8 of the terminal strip and the - terminal of the load to terminal 9 of the terminal strip by means of extra leads (see Fig. 10.b.).
Terminals 3 and 4, and 6 and 7 must be interconnected (see Fig. 10.b.).
The leads to terminals 8 and 9 must be twisted or screened.
Voltage loss in the current-carrying leads to the load may not exceed by the PE 1505 0.4 V (0.2 V per line) and by the PE 1515 1 V (0.5 V per line); otherwise leads of a larger diameter must be used.

### 3. Remote voltage programming

The voltage can be remotely set by means of an external rheostat of 1 kΩ per volt output voltage or with an extra adjustable voltage source of 1 V per voltage output voltage (1 mA).
For connection of the external rheostat see Fig. 10.c. and for connection of the voltage source see Fig. 10.d.
The knob marked "U" must be turned fully clockwise. The leads to terminals 7 and 8 of the terminal strip must be twisted or screened.

4. Remote current programming

The current can also be remotely set by means of an external rheostat of 8.5 Ω (PE 1505) or 28 Ω (PE 1515) per ampere output current (this control is not entirely linear) or with an external adjustable voltage source of 4.3 mV (PE 1505) or 14 mV (PE 1515) per ampere output current (1 mA). The maximum voltage of the voltage source may not exceed 172 mV (PE 1505) or 175 mV (PE 1515).
For connection of the external rheostat see Fig. 10.e. and for connection of the voltage source see Fig. 10.f.
By use of a voltage source the knob marked "I" must be turned fully clockwise.

5. Series connection

Three stabilizers maximum may be connected in series to obtain an output voltage higher than 7.5 V (PE 1505) or 30 V (PE 1515). The voltage between any one of the output terminals and earth may not exceed 90 V ⎓.
Series connection according to "master and slave" system is also possible (see Fig. 10.g.).
If this system is used, the total output voltage can be adjusted with the voltage control of one set (the so-called "master"). Knob marked "U" of the other sets connected in series ( the "slaves") must then be turned fully anti-clockwise and knob marked "I" fully clockwise.

6. Parallel connection

Several stabilizers may be connected in parallel to obtain a higher output current; in this case, the over-voltage protections (crowbars) must be parallel connected (terminal 10 of the terminal strip of each apparatus must be interconnected).
Parallel connection according to "master and slave" system is also possible (see Fig. 10.h.).
If this system is used, the output voltage and the total output current can be adjusted with the control knobs "U" and "I" of one set (master).
Knobs "U" and "I" of the other sets connected in parallel (slaves) must then be turned fully clockwise.

Note: Connect the load symmetrical to the interconnected terminals (see Fig. 10.h.).

# IV. OPERATION

## A. MAINS VOLTAGE

The apparatus is switched on and off with the switch at the bottom right of the front panel (SK2).

Caution: If a switched-on apparatus is opened, pay attention to the fact that parts of the circuit has a mains voltage with respect to earth. These parts are marked red.

## B. OUTPUT VOLTAGE

The output voltage is indicated by the combined volt/ammeter after one of the knobs of switch "METER RANGE" has been set to the correct voltage range.
The output voltage is adjusted with the knob "U".

Over-voltage protection (crowbar)

The circuit connected to the output terminals can be protected against too high voltages with the "OVERVOLTAGE PROTECTION", which is adjustable between 3.5 and 10 V (PE 1505) or 35 V (PE 1515) by means of a potentiometer with screwdriver-adjustment at the rear.
If the voltage at the output terminals exceeds the adjusted value, the "DC FAILURE" lamp lights up and the output voltage decreases. The "U" lamp (voltage stabilization) is extinguished.

As soon as the cause of the over-voltage has been eliminated, the output voltage may be reset by switching the stabilizer on and off.

## C. OUTPUT CURRENT

The output current is also indicated by the combined volt/ammeter after one of the knobs of switch "METER RANGE" has been set to the correct current range.
The output current is adjusted with the knob "I".
If necessary, the output terminals can be short-circuited when adjusting the output current. However, it is advisable to do this at a low output voltage.

Note: During transport, the knobs of switch "METER RANGE" to "out" in order to damp the movement of the moving coil in the meter as much as possible.

# V. ADJUSTMENTS AND CHECKING

## A. GENERAL

Remark: For readjusting and measuring the instrument, it must be connected to mains via an isolating transformer, because part of the circuit presents mains voltage with respect to earth (the relevant parts are marked red).

Following data apply for newly readjusted instruments and can differ from the data mentioned under I.B.

Vn = mains voltage
Vo = output voltage
Δ Vo = output voltage variation
Io = output current
Δ Io = output current variation
Ro = load resistance

## B. ADJUSTMENTS

PE 1505 and PE 1515

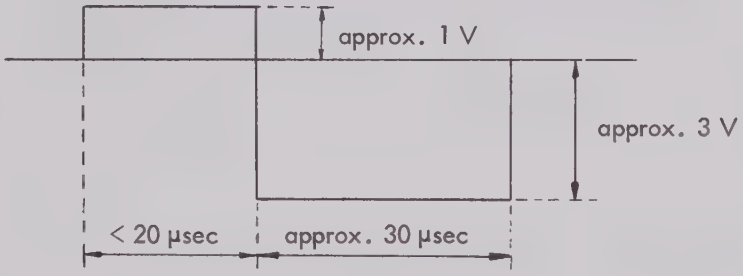
1. U2/R77 Adjusting -15 V (supply control circuit)
   a. Remove VL26 (fuse at transformer T26) and printed wiring board U1
   b. Connect d.c. voltmeter (class 1 %) to U2/C47
   c. Vn: nominal value = 220 V
   d. For U2/R77 select a value between 13 kΩ and 75 kΩ so that the voltage across U2/C47 is between 14.7 and 15.3 V.

2. U2/R151 Adjusting the reference voltage for voltage stabilization
   a. Loosen connection A-B from printed wiring board U2
   b. Connect an mA-meter (class 0.5 %) between A(+) and B(-)
   c. Vn: 220 V
   d. For U2/R151 select a value between 2.4 kΩ to 18 kΩ so that the mA-meter indicates 2.5 mA
   e. After adjustment again make connection A-B

3. U2/R71 Adjusting switch-on delay
   a. Turn U2/R71 completely to the left
   b. Connect a d.c. voltmeter to U2/C57
   c. Vn: 185 V
   d. The voltage across U2/C57 must be < 1 V
   e. Turn U2/R71 slowly to the right, until the moment the voltage across U2/C57 increases to a value between 30 and 42 V.
   f. Reduce Vn
   g. For 170 V < Vn < 180 V the voltage across U2/C57 decreases suddenly to < 1 V

4. Checking unit U1 and U2/R115 Adjusting maximum pulse width

a. Mount printed wiring board U1
b. Turn U12/R1 (U) completely to the left
c. Turn U12/R2 (I) completely to the right
d. Turn U11/R3 completely to the right
e. Connect an oscilloscope between the base of U4/TS29 and the -side of U8/C31
f. Connect a d.c. voltmeter to U8/C31
g. Vn: 220 V
h. The voltage across U8/C31 is 7 V ± 1 V
i. Lamp I lights
j. One line on the oscilloscope
k. Turn U12/R1 (U) slightly to the right
l. On oscilloscope:




m. Connect the oscilloscope between the base of U5/TS31 and the -side of U8/C31
n. Same display as l. on the oscilloscope
o. Place a probe on the wire to the base of U4/TS29
p. Select for U2/R115 a value between 0 and 150 Ω so that the pulse width of the square-wave voltage to the base of U4/TS29 is between 17 and 18 µsec.
q. Turn U12/R1 (U) completely to the left
r. One line on the oscilloscope
s. Discharge U10/C27 via a resistor
t. Mount VL16

PE 1505

5a. U2/R154 Adjusting voltage range

a. Turn U12/R1 (U) completely to the right
b. Depress button 7.5 V of U12/SK1
c. Connect a d.c. voltmeter (class 0.2 %) to the output terminals
d. Vn: 220 V
e. Io: 0 A
f. Select for U2/R154 a value between 43 kΩ and 240 kΩ so that the voltmeter indicates a Vo of 7,6 V
g. Check that lamp U lights
h. Check the deflection of meter U12/ME1

6a. U2/R141 Adjusting current range

a. Turn U12/R1 (U) to the right
b. Turn U12/R2 (I) completely to the right
c. Depress button 40 A of U12/SK1
d. Connect an ammeter (class 0.5 %) in series with an adjustable resistor (0 ÷ 0,2 Ω) to the output terminals
e. Vn: 220 V
f. Select for U2/R141 a value between 9.1 kΩ and 82 kΩ so that the ammeter indicates an Io of 40 A

g. Check that lamp I lights
h. Check the deflection of meter U12/ME1

7a. U2/R95 Symmetrical adjusting of the currents through U4/TS29 and U5/TS31

a. Turn U12/R1 (U) completely to the right
b. Turn U12/R2 (I) completely to the right
c. Place a probe in the primary centre tap of transformer T26
d. Vn: 220 V
e. Ro: 0 Ω
f. Io: 40.0 A
g. Increase Ro until Vo = 7.5 V and Io = 40 A and check if the amplitudes of both currents remain approximately the same.
h. Select for U2/R95 a value between 64.9 kΩ and 100 kΩ so that at Vo = 7.5 V and Io = 40 A, the difference between both currents is 0,2 A max.

8a. U2/R91 Adjusting ripple compensation

a. Connect an oscilloscope or an a.c. voltmeter to the output terminals
b. Vn: 198 V
c. Vo: 7.5 V
d. Io: 40 A
e. With U2/R91 adjust until the smallest ripple is obtained; the ripple measured on the oscilloscope must be $< 14\ mV_{pp}$ or $< 5\ mV_{rms}$

PE 1515

5b. U2/R154 Adjusting voltage range

a. Turn U12/R1 (U) completely to the right.
b. Depress button 30 V of U12/SK1.
c. Connect a d.c. voltmeter (class 0.2 %) to the output terminals
d. Vn: 220 V
e. Io: 0 A
f. Select for U2/R154 a value between 43 kΩ and 240 kΩ so that the voltmeter indicates a Vo of 30.4 V.
g. Check that lamp U lights
h. Check the deflection of meter U12/ME1

6b. U2/R141 Adjusting current range

a. Turn U12/R1 (U) to the right
b. Turn U12/R2 (I) completely to the right
c. Depress button 12.5 A of U12/SK1
d. Connect an ammeter (class 0.5 %) in series with an adjustable resistor (0 ÷ 2.5 Ω) to the output terminals
e. Vn: 220 V
f. Select for U2/R141 a value between 9.1 kΩ and 82 kΩ so that the ammeter indicates an Io of 12.5 A
g. Check that lamp I lights
h. Check the deflection of meter U12/ME1

7b. U2/R95 Symmetrical adjusting of the currents through U4/TS29 and U5/TS31

a. Turn U12/R1 (U) completely to the right
b. Turn U12/R2 (I) completely to the right
c. Place a probe in the primary centre tap of transformer T26

d. Vn: 220 V
e. Ro: 0 Ω
f. Io: 12.5 A
g. Increase Ro until Vo = 30 V and Io = 12.5 A and check if the amplitudes of both currents remain approximately the same.
h. Select for U2/R95 a value between 64.9 kΩ and 100 kΩ so that at Vo = 30 V and Io = 12.5 A, the difference between both currents are 0.2 A max.

8b. U2/R91 Adjusting ripple compensation

a. Connect an oscilloscope or an a.c. voltmeter to the output terminals
b. Vn: 198 V
c. Vo: 30 V
d. Io: 12.5 A
e. Adjust U2/R91 until the smallest ripple is obtained; the ripple measured on the oscilloscope must be $< 8\ mV_{pp}$ or $< 3\ mV_{rms}$

## C. CHECKING

PE 1505

1a. Checking DC failure

a. Turn U12/R1 (U), U12/R2 (I) and U11/R3 to the right
b. Un: 220 V
c. Turn U11/R3 slowly to the left until lamp "DC FAILURE" lights (Lamp U must be extinguished)
d. Vo must be < 1 V
e. Switch off the instrument with U12/SK2
f. Turn U12/R1 (U) and U11/R3 completely to the left
g. Switch on the instrument again with U12/SK2
h. Turn U12/R1 (U) slowly to the right
i. Check on meter U12/ME1 until which value the voltage can be increased. This value must be < 3.5 V
j. Switch off the instrument with U12/SK2
k. Turn U11/R3 to the right

2a. ΔVo at mains voltage variations of + and -10 %

a. Io: 40 A
b. Vn: 198 V ÷ 242 V
c. ΔVo:

| Vo | ΔVo |
|---|---|
| 1.5 V | < 1 mV |
| 7.5 V | < 2.25 mV |

3a. ΔVo at load variations

a. Vn: 220 V
b. ΔVo:

| Vo | Δ Io | ΔVo |
|---|---|---|
| 1 V | 40 → 0 A | < 20 mV |
| 1 V | 0 → 40 A | < 20 mV |
| 7.5 V | 40 → 0 A | < 20 mV |
| 7.5 V | 0 → 40 A | < 20 mV |

4a. Δ Io at mains voltage variations of + and -10 %

a. Connect a shunt of 25 mΩ and Ro of 0.1 Ω in series to the output terminals
b. Turn U12/R1 (U) to the right
c. Vn: 198 V ÷ 242 V
d. Lamp I must light
e. Δ Io: measure as voltage variation ( $\Delta V_{sh}$) at the shunt of 0.1 Ω

| Io | Δ Io | $\Delta V_{sh}$ |
|---|---|---|
| 1 A | < 15 mA | < 0.37 mV |
| 40 A | < 40 mA | < 1.0 mV |

5a. Δ Io at load variations

a. Vn: 220 V
b. Lamp I must light
c. Δ Io: measure as $\Delta V_{sh}$ at the shunt of 25 mΩ

| Io | Vo | Δ Io | $\Delta V_{sh}$ |
|---|---|---|---|
| 40 A | 7.5 and 0.5 V | < 40 mA | < 1 mV |
| 1.5 A | 7.5 and 0.5 V | < 40 mA | < 1 mV |

6a. Ripple voltage

a. Vn: 220 V
b. The ripple voltage measured at the output terminals with an a.c. voltmeter is:

| Δ Vo | Io | Vripple |
|---|---|---|
| 1 → 7.5 V | 1 A | < 5 $mV_{rms}$ |
| 1 → 7.5 V | 40 A | < 5 $mV_{rms}$ |

7a. Ripple current

a. Connect a shunt of 25 mΩ to the output terminals
b. Vn: 220 V
c. Lamps I must light
d. The ripple voltage across the shunt measured with an a.c. voltmeter must be < 2.5 $mV_{rms}$

8a. Checking voltages on the terminal strip at the rear

a. Vn: 220 V
b. Vo: 7.5 V
c. Io: 40 A
d. The voltages measured between:
   -point 1 (-) and 2 (+) must be 160 mV
   -point 2 (+) and 5 (-) must be between 6.2 and 6.8 V
   -point 8 (+) and 9 (-) must be 7.5 V

PE 1515

1b. Checking DC failure

a. Turn U12/R1 (U), U12/R2 (I) and U11/R3 to the right
b. Un: 220 V
c. Turn U11/R3 slowly to the left until lamp "DC FAILURE" lights (lamp U must be extinguished)
d. Vo then must be < 1 V

e. Switch off the instrument with U12/SK2
f. Turn U12/R1 (U) and U11/R3 completely to the left
g. Switch on the instrument again with U12/SK2
h. Turn U12/R1 (U) slowly to the right
i. Check on the meter U12/ME1 until which value the voltage can be increased. This value must be <3.5 V.
j. Switch off the instrument with U12/SK2.
k. Turn U11/R3 to the right

2b. Δ Vo at mains voltage variations of + and -10 %

a. Io: 12.5 A
b. Vn: 198 V ÷ 242 V
c. ΔVo:

| Vo | ΔVo |
|---|---|
| 3 V | < 1 mV |
| 30 V | < 9 mV |

3b. Δ Vo at load variations

a. Vn: 220 V
b. ΔVo:

| Vo | Δ Io | ΔVo |
|---|---|---|
| 3 V | 12.5 → 0 A | < 25 mV |
| 3 V | 0 → 12.5 A | < 25 mV |
| 30 V | 12.5 → 0 A | < 25 mV |
| 30 V | 0 → 12.5 A | < 25 mV |

4b. Δ Io at mains voltage variations of + and -10 %

a. Connect a shunt of 0.1 Ω and a Ro of 1 Ω in series to the output terminals
b. Turn U12/R1 (U) to the right
c. Vn: 198 V ÷ 242 V
d. Lamp I must light
e. Δ Io: measure as voltage variation ($\Delta V_{sh}$) across the shunt of 0.1 Ω

| Io | Δ Io | $\Delta V_{sh}$ |
|---|---|---|
| 500 mA | < 5 mA | < 0.5 mV |
| 12.5 A | < 12.5 mA | < 1.25 mV |

5b. Δ Io at load variations

a. Vn: 220 V
b. Lamp I must light
c. Δ Io: measure as $\Delta V_{sh}$ across the shunt of 0.1 Ω

| Io | Vo | Δ Io | $\Delta V_{sh}$ |
|---|---|---|---|
| 12.5 A | 30 and 1 V | < 12 mA | < 1.2 mV |
| 500 mA | 30 and 1 V | < 12 mA | < 1.2 mV |

6b. Ripple voltage

a. Vn: 220 V
b. The ripple voltage measured at the output terminals with an a.c. voltmeter is:

| ΔVo | Io | Vripple |
|---|---|---|
| 1→30 V | 500 mA | < 3 $mV_{rms}$ |
| 1→30 V | 12.5 A | < 3 $mV_{rms}$ |

7b. Ripple current

a. Connect a shunt of 0.1 Ω to the output terminals
b. Vn: 220 V
c. Lamp I must light
d. The ripple voltage measured across the shunt with an a.c. voltmeter must be < 4 $mV_{rms}$

8b. Checking voltages on the terminal strip at the rear

a. Vn: 220 V
b. Vo: 30 V
c. Io: 12.5 A
d. The voltages measured between:
   -point 1 (-) and 2 (+) must be 160 V
   -point 2 (+) and 5 (-) must be between 6.2 and 6.8 V
   -point 8 (+) and 9 (-) must be 30 V

# VI. TRANSFORMER DATA
# TRANSFORMATORDATEN
# DONNEES DE TRANSFORMATEUR

PE 1505 and PE 1515

| | Winding | Number of turns | Wire diam. in mm | Open voltage in volt |
|---|---|---|---|---|
| U1/T27 | | | | |
| | S1 | 1120 | 0.125 | 2.5 |
| | S2 | 140 | 0.125 | 0.31 |
| U1/T28-29 | | | | |
| | S1 | 120 | 0.28 | 18 |
| | S2 | 26 | 0.28 | 3.9 |
| | S3 | 26 | 0.28 | 3.9 |
| U15/T31 | | | | |
| | S1 | 654 | 0.18 | 110 |
| | S1' | 654 | 0.18 | 110 |
| | S1'' | 2x 107 (par.) | 0.18 | 18 |
| | S2A | 38 | 0.45 | 6.4 |
| | S2B | 38 | 0.45 | 6.4 |
| | S3 | 536 | 0.14 | 90 |
| | S4A | 107 | 0.18 | 18 |
| | S4B | 107 | 0.18 | 18 |
| PE 1505 | | | | |
| U14/T26 | | | | |
| | S1A | 54 | 0.5 | |
| | S1B | 54 | 0.5 | |
| | S2 | 3.5 | 33x0.1 (2x) | |
| | S3 | 3.5 | 33x0.1 (2x) | |
| PE 1515 | | | | |
| U14/T26 | | | | |
| | S1A | 54 | 0.5 | |
| | S1B | 54 | 0.5 | |
| | S2 | 11 | 30x0.1 | |
| | S3 | 11 | 30x0.1 | |

# VII. METER DATA
METERDATEN
DONNEES D'APPAREIL DE MESURE

Current through moving coil at full scale deflection 1 mA.
The meter may have a deviation of 1.5 % of the full scale deflection.
Internal resistance 60 Ω.
Scale: 0 - 7.5; 0-15; 0-40 for PE 1505
0 - 12.5; 0-30 for PE 1515

# VIII. LIST OF MECHANICAL PARTS
## LISTE MECHANISCHER TEILE
## NOMENCLATURE DES COMPOSANTS MECANIQUES

| Item | Fig. | Ordering number | Description |
|---|---|---|---|
| 1 | 3 | 5322 255 10007 | Lamp holder E10 |
| 2 | 3 | 5322 381 10158 | Lens red |
| 3 | 3 | 5322 290 64085 | Mounting support |
| 4 | 3 | 5322 705 31803 | Plate blanc |
| 5 | 3 | 5322 414 34094 | Multiturn dial |
| 6 | 3 | 5322 455 64011 | Text plate (PE 1505) |
| | 3 | 5322 455 64009 | Text plate (PE 1515) |
| 7 | 4 | 5322 256 34019 | Fuse holder |
| 8 | 4, 5 | 5322 290 64084 | Connection strip 10 pole |
| 9 | 4, 5 | 5322 466 94269 | Cover |
| 10 | 4 | 5322 290 40013 | Terminal |
| 11 | 4 | 5322 321 10071 | Mains flex |
| 12 | 4 | 5322 325 60119 | Cable clamp |
| 13 | 5 | 5322 325 64023 | Insulator |
| 14 | 5 | 5322 417 10273 | Hinge |
| 15 | 5 | 5322 466 90729 | Plate |
| 16 | 5 | 5322 462 44074 | Cap |
| 17 | 5 | 5322 255 40073 | Spacer TO18 |
| 18 | 5 | 5322 532 50899 | Ceramic bead 3x1.5 |
| 19 | 5 | 5322 267 60023 | Connector 22 pole |
| 20 | 5 | 5322 255 40006 | Spacer TO1 |
| 21 | 5 | 5322 268 14044 | Lead through |
| 22 | 5 | 5322 325 54028 | Grommet |
| 23 | 5 | 5322 532 24328 | Spacer |
| 24 | 5 | 5322 505 14171 | Special nut |
| 25 | 5 | 5322 532 60487 | Ceramic bead 3x6 |
| 26 | 5 | 5322 401 10038 | Bracket |
| 27 | 5 | 5322 401 10269 | Strip 110 |
| 28 | 5 | 5322 255 40054 | Cooling fin |
| 29 | 6 | 5322 466 94271 | Plate (fuse holder) |
| 30 | 6 | 5322 492 64336 | Spring (fuse holder) |

# IX. LIST OF ELECTRICAL PARTS
## LISTE ELEKTRISCHER TEILE
## NOMENCLATURE DES COMPOSANTS ELECTRIQUES

| Item | Unit | Fig. | Ordering number | Value/Type | | |
|---|---|---|---|---|---|---|
| C26 | U14 | 5 | 5322 121 20173 | 0.1 µF | 20 % | 250 V |
| C27 | U10 | 5 | 5322 124 74043 | 1500 µF | | 350 V |
| C28 | U13 | 5 | 4822 121 50327 | 4700 pF | 1 % | 250 V |
| C29 (PE 1505) | U15 | 5 | 5322 124 74042 | 2x11000 µF | | 16 V |
| C29 (PE 1515) | U15 | 5 | 5322 124 70198 | 2x 2350 µF | | 63 V |
| C30 | U13 | 5 | 4822 121 50329 | 5600 pF | 1 % | 250 V |
| C31 | U8 | 5 | 5322 124 74041 | 4700 µF | | 10 V |
| C32 | U1 | 11 | 4822 124 20426 | 2200 µF | | 10 V |
| C33 | U2 | 12 | 4822 124 20351 | 6.8 µF | | 40 V |
| C34 | U1 | 11 | 4822 124 20424 | 2200 µF | | 6.3 V |
| C36-37 | U7 | 5 | 4822 121 41339<br>~~5322~~ 121 44114 | 2200 pF | 5 % | 1500 V |
| C38 | U1 | 11 | 4822 124 20155 | 10 µF | | 400 V |
| C39 | U2 | 12 | 5322 121 40054 | 33000 pF | 10 % | 250 V |
| C41-42 | U2 | 12 | 4822 124 20419 | 1000 µF | | 25 V |
| C43 | U2 | 12 | 5322 121 40209 | 0.33 µF | 10 % | 250 V |
| C44 | U2 | 12 | 5322 121 40059 | 0.1 µF | 10 % | 250 V |
| C46 | U2 | 12 | 5322 121 50502 | 15000 pF | 1 % | 63 V |
| C47 | U2 | 12 | 4822 124 20346 | 4.7 µF | | 63 V |
| C48 | U2 | 12 | 5322 121 50503 | 4300 pF | 1 % | 63 V |
| C49-51 | U2 | 12 | 4822 120 20081 | 100 pF | 20 % | 500 V |
| C52-53 | U2 | 12 | 5322 121 50415 | 2200 pF | 1 % | 63 V |
| C54 | U2 | 12 | 5322 121 50503 | 4300 pF | 1 % | 63 V |
| C56 | U2 | 12 | 5322 121 40059 | 0.1 µF | 10 % | 250 V |
| C57 | U2 | 12 | 4822 124 20356 | 15 µF | | 63 V |
| C58 | U2 | 12 | 5322 121 40209 | 0.33 µF | 10 % | 250 V |
| C59 | U2 | 12 | 4822 124 20346 | 4.7 µF | | 63 V |
| C61 | U2 | 12 | 5322 124 20411 | 680 µF | | 16 V |
| C63 | U2 | 12 | 5322 121 40059 | 0.1 µF | 10 % | 250 V |
| C64 | U2 | 12 | 4822 120 20063 | 22 pF | 20 % | 500 V |
| C66 | U2 | 12 | 5322 122 30048 | 1800 pF | 10 % | 100 V |
| C67 | U2 | 12 | 5322 122 30115 | 560 pF | 10 % | 100 V |
| C68 | U2 | 12 | 5322 122 30048 | 1800 pF | 10 % | 100 V |
| C69 | U2 | 12 | 4822 120 20063 | 22 pF | 20 % | 500 V |
| C70 (PE 1505) | U11 | 5a | 5322 121 40176 | 1 µF | 20 % | 100 V |
| C71 | U2 | 12 | 5322 122 30115 | 560 pF | 10 % | 100 V |
| C72 | U2 | 12 | 5322 121 30048 | 1 µF | 10 % | 250 V |
| C73 | U2 | 12 | 5322 121 40057 | 68000 pF | 10 % | 250 V |
| C74-76 | U2 | 12 | 5322 121 40209 | 0.33 µF | 10 % | 250 V |
| C75 (PE 1505) | U11 | 5a | 5322 121 20173 | 0.1 µF | 20 % | 250 V |
| C77 | U2 | 12 | 5322 121 40079 | 0.22 µF | 10 % | 250 V |

| Item | Unit | Fig. | Ordering number | Value/Type | | |
|---|---|---|---|---|---|---|
| C78 | U2 | 12 | 5322 121 40209 | 0.33 µF | 10 % | 250 V |
| C79 | U2 | 12 | 5322 121 40049 | 15000 pF | 10 % | 250 V |
| C80 (PE 1505) | U11 | 5a | 5322 124 20388 | 150 µF | | 25 V |
| C80 (PE 1515) | U11 | 5b | 5322 124 20372 | 47 µF | | 63 V |
| C81 (PE 1505) | U15 | 5 | 5322 124 74042 | 2x11000 µF | | 16 V |
| C81 (PE 1515) | U15 | 5 | 5322 124 70198 | 2x 2350 µF | | 63 V |
| C82 | U2 | 12 | 5322 121 40104 | 0.15 µF | 10 % | 250 V |
| C83-84 (PE 1505) | U11 | 5a | 5322 121 20173 | 0.1 µF | 20 % | 250 V |
| C83-84 (PE 1515) | U16 | 5b | 5322 121 20173 | 0.1 µF | 20 % | 250 V |
| C85 (PE 1505) | U11 | 5a | 5322 124 20355 | 10 µF | | 25 V |
| C86 (PE 1515) | U2 | 12 | 5322 121 40209 | 0.33 µF | 10 % | 250 V |
| C87-88 | U2 | 12 | 5322 121 40054 | 33000 pF | 10 % | 250 V |
| F26 | U16 | 5 | 5322 121 44112 | Filter Hydra 9768 | | |
| F27 | U11 | 5 | 5322 121 44113 | Filter ERO | | |
| GR26-27 | U3 | 5 | 5322 130 34223 | BYX42/900R | | |
| GR28-29 | U3 | 5 | 5322 130 34224 | BYX42/900 | | |
| GR31-32 | U9 | 5 | 5322 130 34225 | BYX46/200 (PE 1505 3x par.) | | |
| GR34 | U1 | 11 | 5322 130 30414 | BY164 | | |
| GR37÷41 | U1 | 11 | 5322 130 30424 | BAX12 | | |
| GR42 | U2 | 12 | 5322 130 30195 | BYX10 | | |
| GR43 | U2 | 12 | 5322 130 30424 | BAX12 | | |
| GR44 | U2 | 12 | 5322 130 30414 | BY164 | | |
| GR46 | U2 | 12 | 5322 130 30424 | BAX12 | | |
| GR47 | U2 | 12 | 5322 130 34069 | BZX79/C12 | | |
| GR48 | U2 | 12 | 5322 130 40182 | BAX13 | | |
| GR51 | U2 | 12 | 5322 130 34047 | BZX75/C1V4 | | |
| GR52 | U2 | 12 | 5322 130 30766 | BZX79/C6V2 | | |
| GR53 | U2 | 12 | 5322 130 30759 | BZX79/C5V6 | | |
| GR54 | U2 | 12 | 5322 130 30765 | BZX75/C3V6 | | |
| GR56 | U2 | 12 | 5322 130 40182 | BAX13 | | |
| GR57 | U2 | 12 | 5322 130 30759 | BZX79/C5V6 | | |
| GR58÷62 | U2 | 12 | 5322 130 40182 | BAX13 | | |
| GR63-64 | U2 | 12 | 5322 130 30273 | BAX16 | | |
| GR66÷69 | U2 | 12 | 5322 130 40182 | BAX13 | | |
| GR70 | U2 | 12 | 5322 130 34048 | BZX75/C2V8 | | |
| GR71 | U2 | 12 | 5322 130 30766 | BZX79/C6V2 | | |
| GR72 | U2 | 12 | 5322 130 40182 | BAX13 | | |
| GR73 | U2 | 12 | 5322 130 30424 | BAX12 | | |
| GR74 | U2 | 12 | 5322 130 34269 | BZV12 | | |
| GR75 | U2 | 12 | 5322 130 34048 | BZX75/C2V8 | | |
| GR76 | U2 | 12 | 5322 130 30424 | BAX12 | | |
| GR77 | U2 | 12 | 5322 130 34269 | BZV12 | | |
| GR78 | U2 | 12 | 5322 130 30759 | BZX79/C5V6 | | |
| GR79 | U2 | 12 | 5322 130 40182 | BAX13 | | |
| IC26-27 | U2 | 12 | 5322 209 80068 | TAA521 | | |
| LA1-2 | U12 | 3, 5 | 5322 134 20014 | Neon lamp GL14D | | |
| LA3 | U12 | 3, 5 | 5322 134 40065 | Signal lamp 8108D | | |
| L26 | U15 | 5 | 5322 152 24018 | Choke | | |
| L27-28 | U14 | 5 | - | 2x choke on transformer T26 | | |
| L101-1,2 (PE 1505) | U16 | 5a | 5322 526 14015 | Ferroxcube ring | | |

| Item | Unit | Fig. | Ordering number | Value/Type | | | |
|---|---|---|---|---|---|---|---|
| ME1 (PE 1505) | U12 | 3, 5 | 5322 344 64045 | V/A meter | | | |
| ME1 (PE 1515) | U12 | 3, 5 | 5322 344 64046 | V/A meter | | | |
| R1 | U12 | 3, 5 | 5322 103 54007 | 1 | kΩ | 3 % | 3 W 10 turn |
| R2 | U12 | 3, 5 | 5322 103 54008 | 100 | Ω | 3 % | 3 W 10 turn |
| R3 | U11 | 4, 5 | 5322 101 20059 | 2.2 | kΩ | 20 % | CP23 |
| R25 | U12 | 5 | 4822 110 50187 | 1 | MΩ | 5 % | CR37 |
| R26 | U3 | 5 | 4822 110 20069 | 39 | Ω | 5 % | CR68 |
| R27 | U10 | 5 | 5322 113 44127 | 27 | kΩ | 5 % | WR0825E |
| R28 | U13 | 5 | 4822 112 20081 | 100 | Ω | 5 % | WR0617E(2x par.) |
| R29 (PE 1505) | U16 | 5 | 5322 115 84008 | shunt 4 mΩ | | | |
| R29 (PE 1515) | U16 | 5 | 5322 115 84007 | shunt 12.8 mΩ | | | |
| R30-31 | U1 | 11 | 4822 110 50061 | 18 | Ω | 5 % | CR37 |
| R32 | U1 | 11 | 4822 110 50085 | 150 | Ω | 5 % | CR37 |
| R33 | U1 | 11 | 4822 110 50072 | 47 | Ω | 5 % | CR37 |
| R34 | U1 | 11 | 5322 113 60002 | 2 | Ω | 10 % | 2 W |
| R36 | U1 | 11 | 4822 110 50072 | 47 | Ω | 5 % | CR37 |
| R37 | U1 | 11 | 4822 110 40094 | 330 | Ω | 5 % | CR52 |
| R38 | U1 | 11 | 4822 110 53041 | 3.3 | Ω | 5 % | CR37 |
| R39 | U1 | 11 | 4822 110 50076 | 68 | Ω | 5 % | CR37 |
| R41-42 | U4, 5 | 5 | 5322 113 44113 | 82 | Ω | 5 % | WR0825E |
| R43 | U1 | 11 | 4822 110 50076 | 68 | Ω | 5 % | CR37 |
| R44 | U1 | 11 | 4822 110 53041 | 3.3 | Ω | 5 % | CR37 |
| R46 | U1 | 11 | 4822 110 40094 | 330 | Ω | 5 % | CR52 |
| R47 | U1 | 11 | 4822 110 50072 | 47 | Ω | 5 % | CR37 |
| R48 | U1 | 11 | 4822 110 50085 | 150 | Ω | 5 % | CR37 |
| R49 | U1 | 11 | 4822 110 50072 | 47 | Ω | 5 % | CR37 |
| R50 | U2 | 12 | 5322 110 60098 | 470 | Ω | 5 % | CR25 |
| R51 | U1 | 11 | 5322 113 60002 | 2 | Ω | 10 % | 2 W |
| R52 | U1 | 11 | 4822 112 20045 | 4.7 | Ω | 10 % | WR0617E |
| R53 | U2 | 12 | 5322 110 60144 | 24 | kΩ | 5 % | CR25 |
| R54 | U2 | 12 | 5322 110 60157 | 75 | kΩ | 5 % | CR25 |
| R55 | U2 | 12 | 5322 110 60123 | 3.9 | kΩ | 5 % | CR25 |
| R56 | U2 | 12 | 5322 110 60115 | 2 | kΩ | 5 % | CR25 |
| R57 | U2 | 12 | 5322 110 60131 | 7.5 | kΩ | 5 % | CR25 |
| R58 | U2 | 12 | 5322 110 60149 | 39 | kΩ | 5 % | CR25 |
| R59 | U2 | 12 | 5322 110 60122 | 3.6 | kΩ | 5 % | CR25 |
| R61 | U2 | 12 | 5322 116 54155 | 100 | kΩ | 1 % | MR25 |
| R62 | U2 | 12 | 5322 110 60093 | 300 | Ω | 5 % | CR25 |
| R63 | U2 | 12 | 5322 110 60114 | 1.8 | kΩ | 5 % | CR25 |
| R64 | U2 | 12 | 5322 110 60117 | 2.4 | kΩ | 5 % | CR25 |
| R66 | U2 | 12 | 5322 110 60124 | 4.3 | kΩ | 5 % | CR25 |
| R67 | U2 | 12 | 5322 110 60116 | 2.2 | kΩ | 5 % | CR25 |
| R68 | U2 | 12 | 5322 110 60134 | 10 | kΩ | 5 % | CR25 |
| R69 | U2 | 12 | 4822 110 50107 | 1 | kΩ | 5 % | CR37 |
| R71 | U2 | 12 | 5322 100 10036 | 4.7 | kΩ | 20 % | 0.1 W |
| R72 | U2 | 12 | 5322 110 60138 | 15 | kΩ | 5 % | CR25 |
| R73 | U2 | 12 | 5322 110 60121 | 3.3 | kΩ | 5 % | CR25 |
| R74 | U2 | 12 | 5322 116 54221 | 3.65 | kΩ | 1 % | MR25 |
| R76 | U2 | 12 | 5322 116 54011 | 5.62 | kΩ | 1 % | MR25 |

| Item | Unit | Fig. | Ordering number | Value/Type | | | |
|---|---|---|---|---|---|---|---|
| R77 | U2 | 12 | 5322 110 60... | 13 kΩ...75 kΩ | | 5 % | CR25 |
| R78 | U2 | 12 | 5322 116 50479 | 15.4 | kΩ | 1 % | MR25 |
| R79 | U2 | 12 | 5322 116 50584 | 620 | Ω | 5 % | CR37 |
| R81 | U2 | 12 | 5322 110 60134 | 10 | kΩ | 5 % | CR25 |
| R82 | U2 | 12 | 5322 110 40081 | 100 | Ω | 5 % | CR52 |
| R83 | U2 | 12 | 5322 110 60116 | 2.2 | kΩ | 5 % | CR25 |
| R84 | U2 | 12 | 5322 110 60109 | 1.2 | kΩ | 5 % | CR25 |
| R86 | U2 | 12 | 5322 110 60107 | 1 | kΩ | 5 % | CR25 |
| R87 | U2 | 12 | 5322 116 50478 | 16.9 | kΩ | 1 % | MR25 |
| R88 | U2 | 12 | 5322 110 60115 | 2 | kΩ | 5 % | CR25 |
| R89 | U2 | 12 | 5322 116 50525 | 14.7 | kΩ | 1 % | MR25 |
| R90 | U2 | 12 | 5322 110 60074 | 56 | Ω | 5 % | CR25 |
| R91 | U2 | 12 | 5322 100 10075 | 100 | Ω | 20 % | 0.1 W |
| R92 | U2 | 12 | 5322 116 50478 | 16.9 | kΩ | 1 % | MR25 |
| R93 | U2 | 12 | 5322 110 60109 | 1.2 | kΩ | 5 % | CR25 |
| R94 | U2 | 12 | 5322 110 60107 | 1 | kΩ | 5 % | CR25 |
| R95 | U2 | 12 | 5322 116 5.... | 64.9 kΩ...100 kΩ | | 1 % | MR25 |
| R96 | U2 | 12 | 5322 110 60094 | 330 | Ω | 5 % | CR25 |
| R97 | U2 | 12 | 5322 116 50396 | 20.5 | kΩ | 1 % | MR25 |
| R98 | U2 | 12 | 5322 116 50559 | 27.4 | kΩ | 1 % | MR25 |
| R99 | U2 | 12 | 5322 110 60135 | 11 | kΩ | 5 % | CR25 |
| R101 | U2 | 12 | 5322 110 60125 | 4.7 | kΩ | 5 % | CR25 |
| R102 | U2 | 12 | 5322 110 60107 | 1 | kΩ | 5 % | CR25 |
| R103 | U2 | 12 | 5322 110 60069 | 39 | Ω | 5 % | CR25 |
| R104-106 | U2 | 12 | 5322 110 60107 | 1 | kΩ | 5 % | CR25 |
| R107 | U2 | 12 | 5322 110 60118 | 2.7 | kΩ | 5 % | CR25 |
| R109 | U2 | 12 | 5322 110 60129 | 6.8 | kΩ | 5 % | CR25 |
| R111 | U2 | 12 | 5322 110 60137 | 13 | kΩ | 5 % | CR25 |
| R112 | U2 | 12 | 5322 110 60122 | 3.6 | kΩ | 5 % | CR25 |
| R113 | U2 | 12 | 5322 110 60112 | 1.5 | kΩ | 5 % | CR25 |
| R114 | U2 | 12 | 5322 110 60099 | 510 | Ω | 5 % | CR25 |
| R115 | U2 | 12 | 5322 110 60... | 0 Ω...150 Ω | | 5 % | CR25 |
| R116÷118 | U2 | 12 | 5322 110 60125 | 4.7 | kΩ | 5 % | CR25 |
| R119 | U2 | 12 | 5322 110 60129 | 6.8 | kΩ | 5 % | CR25 |
| R121 | U2 | 12 | 5322 110 60116 | 2.2 | kΩ | 5 % | CR25 |
| R122 | U2 | 12 | 5322 110 60138 | 15 | kΩ | 5 % | CR25 |
| R123 | U2 | 12 | 5322 110 60137 | 13 | kΩ | 5 % | CR25 |
| R124 | U2 | 12 | 5322 110 60125 | 4.7 | kΩ | 5 % | CR25 |
| R126 | U2 | 12 | 5322 110 60138 | 15 | kΩ | 5 % | CR25 |
| R127 | U2 | 12 | 5322 110 60112 | 1.5 | kΩ | 5 % | CR25 |
| R128 | U2 | 12 | 5322 110 60189 | 1.2 | MΩ | 10 % | CR25 |
| R129 | U2 | 12 | 5322 110 60112 | 1.5 | kΩ | 5 % | CR25 |
| R131 | U2 | 12 | 5322 110 60138 | 15 | kΩ | 5 % | CR25 |
| R132 | U2 | 12 | 4822 110 60196 | 2.2 | MΩ | 10 % | CR25 |
| R133-134 | U2 | 12 | 5322 110 60072 | 47 | Ω | 5 % | CR25 |
| R136-137 | U2 | 12 | 5322 116 54051 | 1.05 | kΩ | 1 % | MR24 |
| R138 | U2 | 12 | 5322 116 50511 | 48.7 | Ω | 1 % | MR25 |
| R139 | U2 | 12 | 5322 116 51059 | 34.8 | kΩ | 1 % | MR25 |
| R141 | U2 | 12 | 5322 110 60... | 9.1 kΩ...82 kΩ | | 5 % | CR25 |
| R142 | U2 | 12 | 5322 116 54049 | 4.64 | kΩ | 1 % | MR24 |

| Item | Unit | Fig. | Ordering number | Value/Type | | | |
|---|---|---|---|---|---|---|---|
| R143 | U2 | 12 | 5322 116 50443 | 12.7 | kΩ | 1 % | MR24 |
| R144 | U2 | 12 | 5322 116 54189 | 2.15 | kΩ | 1 % | MR24 |
| R146 | U2 | 12 | 5322 116 50765 | 909 | Ω | 1 % | MR25 |
| R147 | U2 | 12 | 5322 116 50669 | 205 | Ω | 1 % | MR25 |
| R148 | U2 | 12 | 5322 116 54191 | 30.1 | kΩ | 1 % | MR25 |
| R149 | U2 | 12 | 5322 116 50765 | 909 | Ω | 1 % | MR25 |
| R150 (PE 1505) | U11 | 5a | 5322 110 60085 | 150 | Ω | 5 % | CR25 |
| R151 | U2 | 12 | 5322 110 60... | 2.4 kΩ...18 kΩ | | 5 % | CR25 |
| R152 | U2 | 12 | 5322 116 50765 | 909 | Ω | 1 % | MR25 |
| R153 | U2 | 12 | 5322 116 50945 | 7.15 | kΩ | 1 % | MR24 |
| R154 | U2 | 12 | 5322 110 60... | 43 kΩ...240 kΩ | | 5 % | CR25 |
| R156 (PE 1505) | U2 | 12 | 5322 116 54202 | 7.5 | kΩ | 1 % | MR24 |
| R156 (PE 1515) | U2 | 12 | 5322 116 54191 | 30.1 | kΩ | 1 % | MR24 |
| R157 | U2 | 12 | 5322 110 60109 | 1.2 | kΩ | 5 % | CR25 |
| R158 | U2 | 12 | 5322 116 50748 | 10 | kΩ | 1 % | MR25 |
| R159 (PE 1505) | U2 | 12 | 5322 110 60103 | 680 | Ω | 5 % | CR25 |
| R159 (PE 1515) | U2 | 12 | 5322 110 60087 | 180 | Ω | 5 % | CR25 |
| R161 | U2 | 12 | 4822 110 60045 | 4.7 | Ω | 5 % | CR25 |
| R162 | U2 | 12 | 5322 110 60134 | 10 | kΩ | 5 % | CR25 |
| R163 | U2 | 12 | 5322 110 60127 | 5.6 | kΩ | 5 % | CR25 |
| R164 | U2 | 12 | 5322 110 60115 | 2 | kΩ | 5 % | CR25 |
| R166 | U2 | 12 | 4822 110 50098 | 470 | Ω | 5 % | CR37 |
| R167 | U2 | 12 | 5322 110 60099 | 510 | Ω | 5 % | CR25 |
| R168 (PE 1505) | U2 | 12 | 5322 116 50558 | 18.7 | kΩ | 1 % | MR25 |
| R168 (PE 1515) | U2 | 12 | 5322 116 54151 | 68.1 | kΩ | 1 % | MR25 |
| R169 | U2 | 12 | 4822 110 60045 | 4.7 | Ω | 5 % | CR25 |
| R170 (PE 1505) | - | 5 | 5322 113 44126 | 15 | Ω | 10 % | WR0825E |
| R170 (PE 1515) | - | 5 | 5322 113 44125 | 220 | Ω | 5 % | WR0825E |
| R171 | U2 | 12 | 4822 110 50083 | 120 | Ω | 5 % | CR37 |
| R172 | U2 | 12 | 5322 110 60093 | 300 | Ω | 5 % | CR25 |
| R173 (PE 1505) | U12 | 5 | 5322 116 54202 | 7.5 | kΩ | 1 % | MR25 |
| R173 (PE 1515) | U12 | 5 | 5322 116 50572 | 12.1 | kΩ | 1 % | MR25 |
| R174 (PE 1515) | U12 | 5b | 5322 116 54289 | 17.8 | kΩ | 1 % | MR25 |
| R175 (PE 1505) | U11 | 5a | 4822 110 40027 | 1 | Ω | 5 % | CR52 |
| R176 | U12 | 5 | 5322 116 50746 | 100 | Ω | 1 % | MR25 |
| R178-179 | U2 | 12 | 5322 116 50746 | 100 | Ω | 1 % | MR25 |
| SK1 | U12 | 3, 5 | 5322 276 34008 | Selector switch | | | |
| SK2 | U12 | 3, 5 | 5322 277 10167 | Mains switch 16 A | | | |
| T26 (PE 1505) | U14 | 5 | 5322 146 24048 | Transformer (+ L27 en 28) | | | |
| T26 (PE 1515) | U14 | 5 | 5322 146 24047 | Transformer (+ L27 en 28) | | | |
| T27 | U1 | 11 | 5322 148 84011 | Filter transformer | | | |
| T28-29 | U1 | 11 | 5322 148 84012 | Pulse transformer | | | |
| T31 | U15 | 5 | 5322 146 34024 | Mains transformer | | | |
| TS27 | U6 | 5 | 5322 130 40852 | BDY60 | | | |
| TS28 | U1 | 11 | 5322 130 44144 | BSV64 | | | |
| TS29-31 | U4, 5 | 5 | 5322 130 44202 | BDY96 | | | |
| TS32 | U1 | 11 | 5322 130 44144 | BSV64 | | | |
| TS33 | U6 | 5 | 5322 130 40852 | BDY60 | | | |

| Item | Unit | Fig. | Ordering number | Value/Type |
|---|---|---|---|---|
| TS34-36 | U2 | 12 | 5322 130 40325 | BCY56 |
| TS37 | U2 | 12 | 5322 130 40373 | BCY71 |
| TS38 | U2 | 12 | 5322 130 40325 | BCY56 |
| TS39 | U2 | 12 | 5322 130 40021 | 2N2905 |
| TS41 | U2 | 12 | 5322 130 40373 | BCY71 |
| TS42 | U2 | 12 | 5322 130 40021 | 2N2905 |
| TS43 | U2 | 12 | 5322 130 40462 | BFY52 |
| TS44 | U2 | 12 | 5322 130 40325 | BCY56 |
| TS46-47 | U2 | 12 | 5322 130 40417 | BSX20 |
| TS48-1-2 | U2 | 12 | 5322 130 30188 | BCY89 |
| TS49-51 | U2 | 12 | 5322 130 40325 | BCY56 |
| TS52-53 | U2 | 12 | 5322 130 40021 | 2N2905 |
| TS54-56 | U2 | 12 | 5322 130 40373 | BCY71 |
| TS57-1-2 | U2 | 12 | 5322 130 30188 | BCY89 |
| TS58 | U2 | 12 | 5322 130 44037 | BF337 |
| TS59-1-2 | U2 | 12 | 5322 130 30188 | BCY89 |
| TS61 | U2 | 12 | 5322 130 40021 | 2N2905 |
| TS62 | U2 | 12 | 5322 130 24001 | BTX18/100 |
| TS63 | U9 | 5 | 5322 130 20011 | BTY91/400R |
| U1 | - | 5, 11 | 5322 216 44017 | Control unit, print assy |
| U2 (PE 1505) | - | 5, 12 | 5322 216 44019 | Amplifier unit, print assy |
| U2 (PE 1515) | - | 5, 12 | 5322 216 44018 | Amplifier unit, print assy |
| VL1-2 | U11 | 4, 5 | 5322 253 30031 | 6.3 A delayed |
| VL26 | U14 | 6 | 5322 253 20025 | 3.15 A very fast |

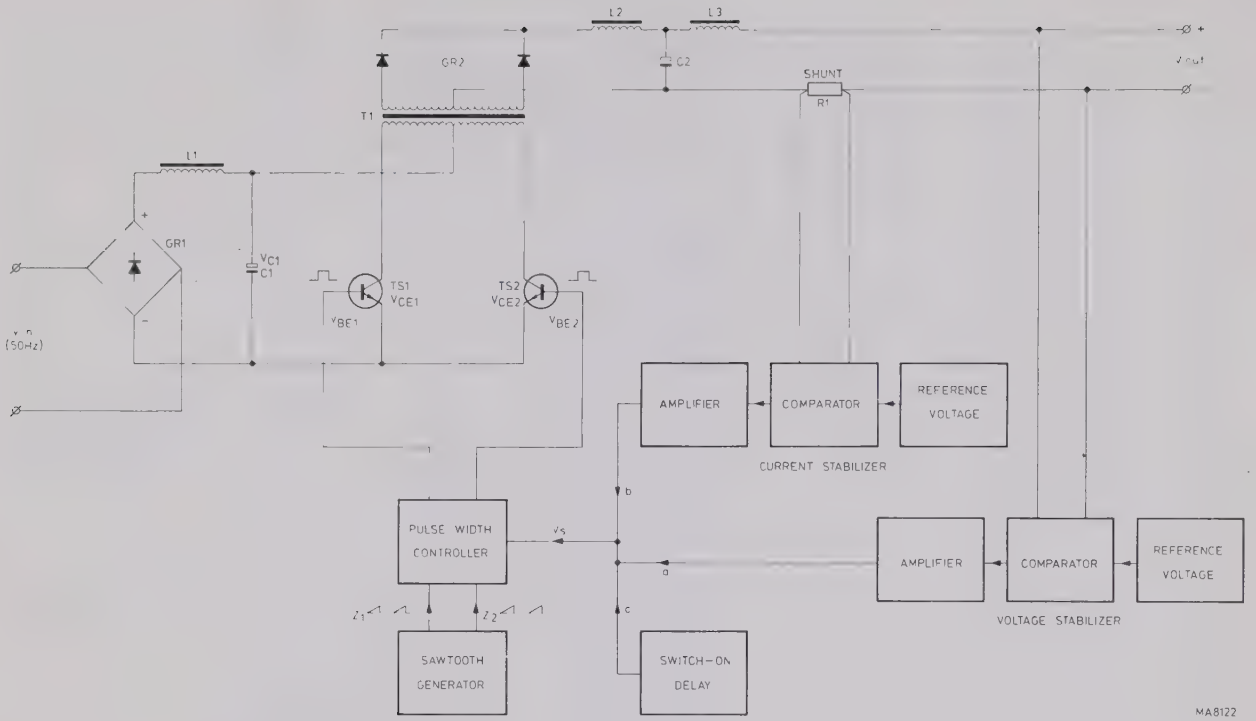

L2
L3
GR2
C2
SHUNT
R1
T1
L1
GR1
C1
TS1
TS2
AMPLIFIER
COMPARATOR
REFERENCE VOLTAGE
CURRENT STABILIZER
PULSE WIDTH CONTROLLER
AMPLIFIER
COMPARATOR
REFERENCE VOLTAGE
VOLTAGE STABILIZER
SAWTOOTH GENERATOR
SWITCH-ON DELAY
MA8122

Fig. 1

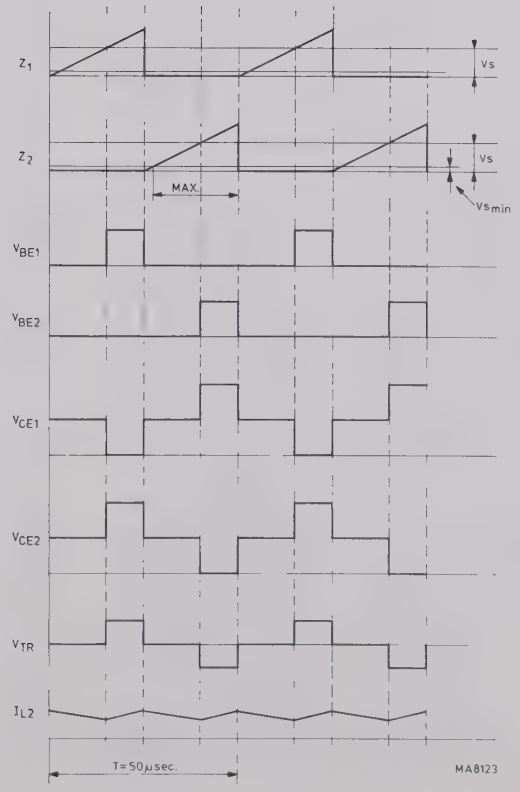

Z1
Z2
Vs
MAX.
Vsmin
VBE1
VBE2
VCE1
VCE2
VTR
IL2
T=50µsec.
MA8123

Fig. 2

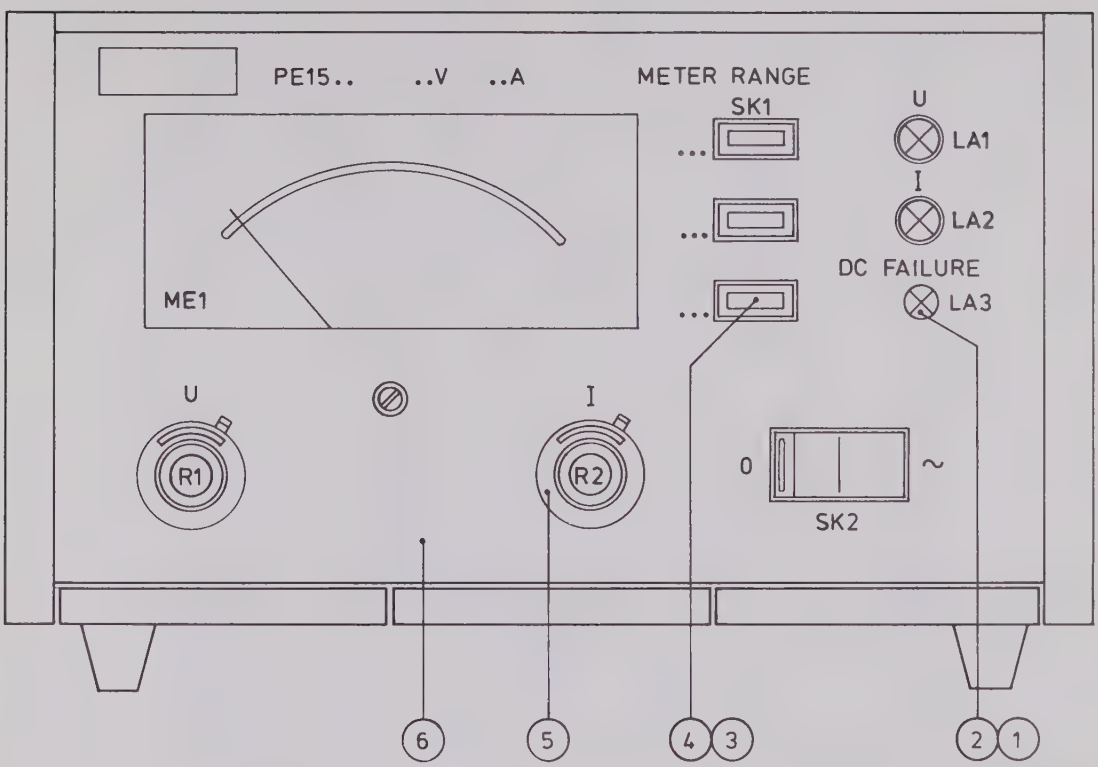

PE15..
..V
..A
METER RANGE
SK1
U
LA1
I
LA2
DC FAILURE
LA3
ME1
U
R1
I
R2
0
~
SK2
6
5
4
3
2
1
MA8124

Fig. 3

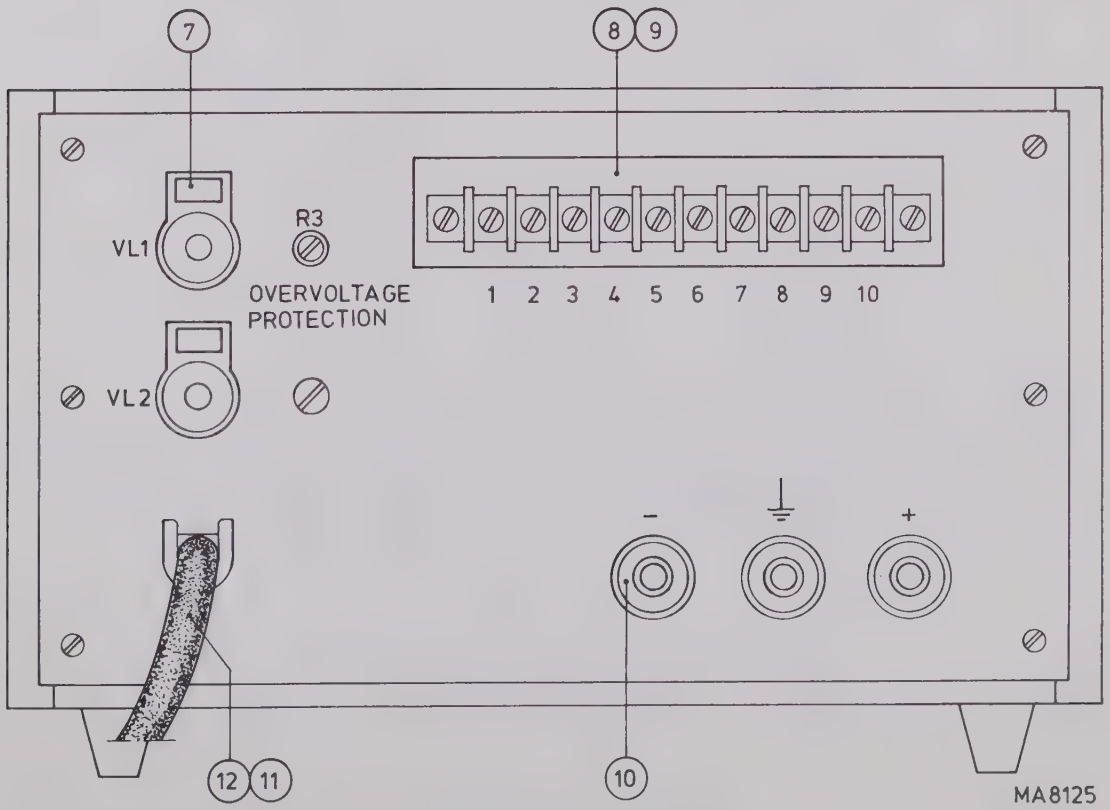

7
8
9
VL1
R3
OVERVOLTAGE
PROTECTION
1 2 3 4 5 6 7 8 9 10
VL2
–
+
12
11
10
MA8125

Fig. 4

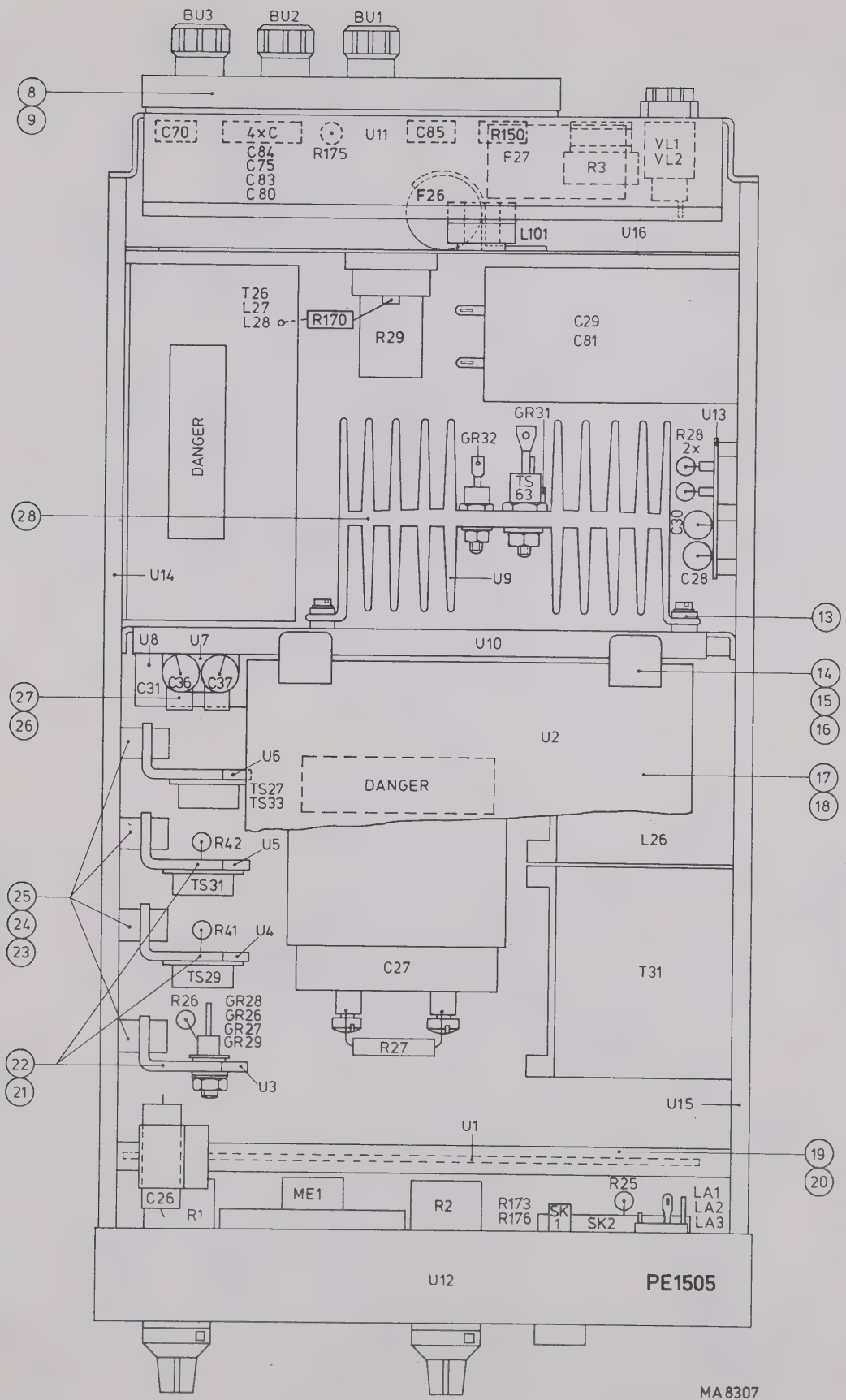
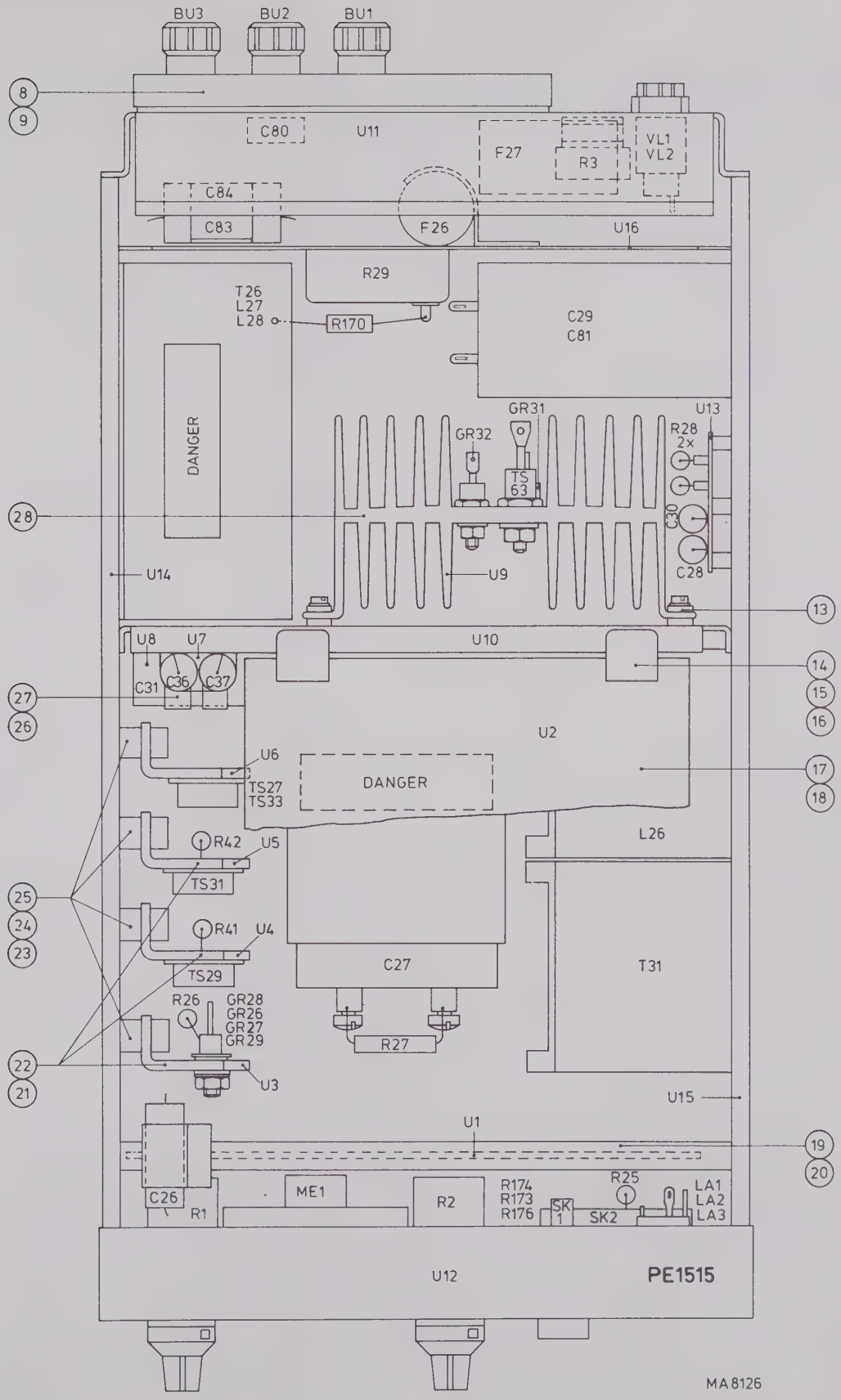

BU3
BU2
BU1
8
9
C70
4xC
C84
C75
C83
C80
R175
U11
C85
R150
F27
R3
VL1
VL2
F26
L101
U16
T26
L27
L28
R170
R29
C29
C81
DANGER
GR31
GR32
U13
R28
2x
TS
63
C30
C28
28
U14
U9
13
U8
U7
U10
C31
C36
C37
14
15
16
27
26
U2
U6
TS27
TS33
DANGER
17
18
L26
R42
U5
TS31
25
24
23
R41
U4
TS29
C27
T31
R26
GR28
GR26
GR27
GR29
R27
22
21
U3
U15
U1
19
20
C26
R1
ME1
R2
R173
R176
SK
1
SK2
R25
LA1
LA2
LA3
U12
PE1505
MA 8307

Fig. 5a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BU2
BU1
8
9
C80
U11
F27
R3
VL1
VL2
C84
C83
F26
U16
R29
T26
L27
L28
R170
C29
C81
DANGER
GR31
GR32
U13
R28
2x
TS
63
C30
C28
28
U14
U9
13
U8
U7
U10
14
C31
C36
C37
27
15
26
16
U2
U6
17
TS27
TS33
DANGER
18
L26
R42
U5
TS31
25
24
R41
U4
23
TS29
C27
T31
R26
GR28
GR26
GR27
GR29
R27
22
U3
21
U15
U1
19
20
C26
R1
ME1
R2
R174
R173
R176
SK
1
SK2
R25
LA1
LA2
LA3
U12
PE1515
MA8126

Fig. 5b

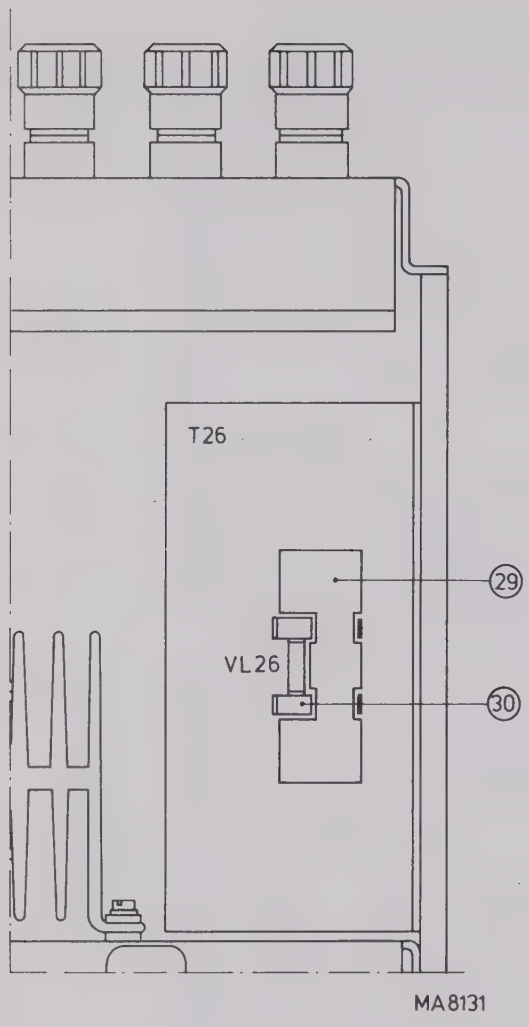



Fig. 6

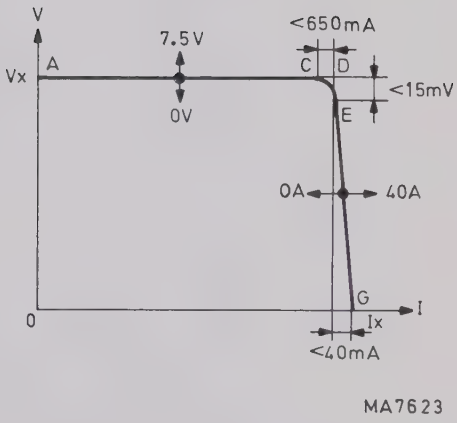



Fig. 7

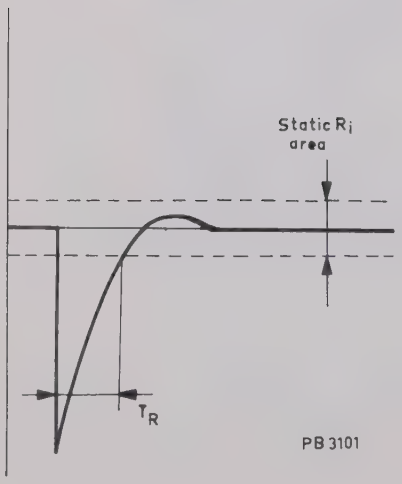



Fig. 9

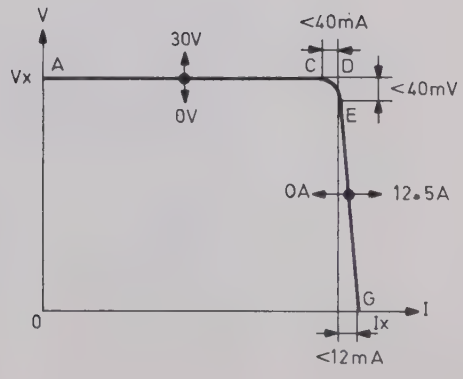



Fig. 8

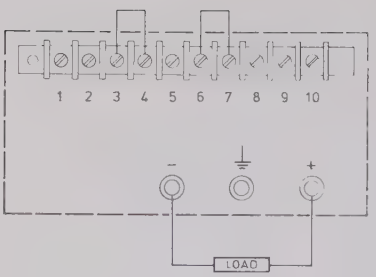



Fig. 10a
Normal use

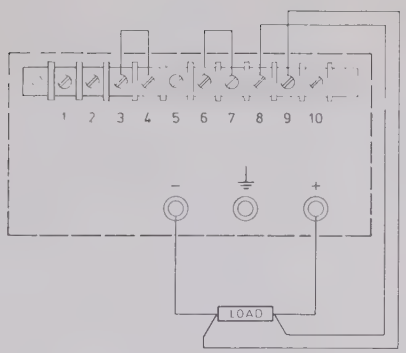



Fig. 10b
Remote sensing

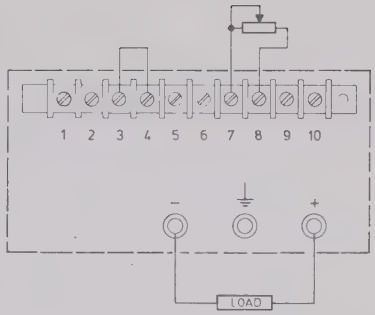



Fig. 10c
Remote voltage control
with external resistor

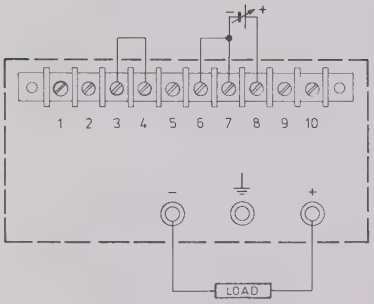



Fig. 10d
Remove voltage control
with external voltage

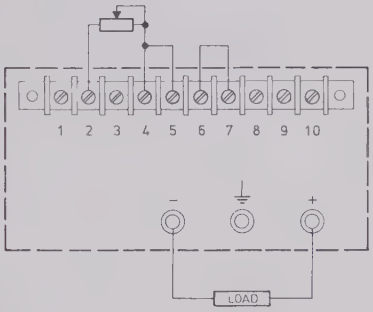



Fig. 10e
Remote current control
with external resistor

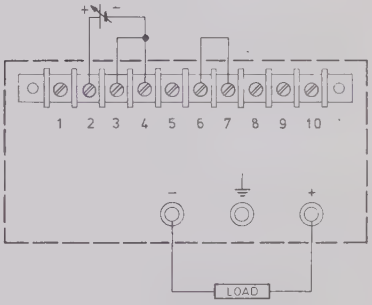



Fig. 10f
Remote current control
with external voltage

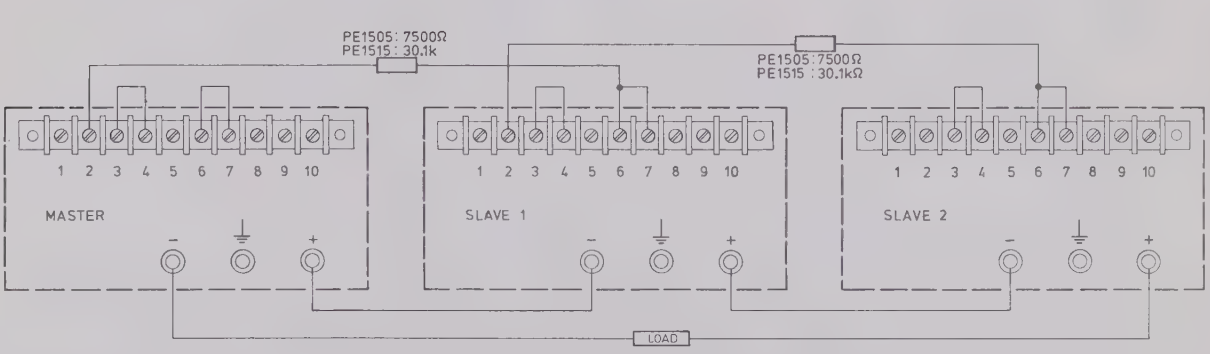
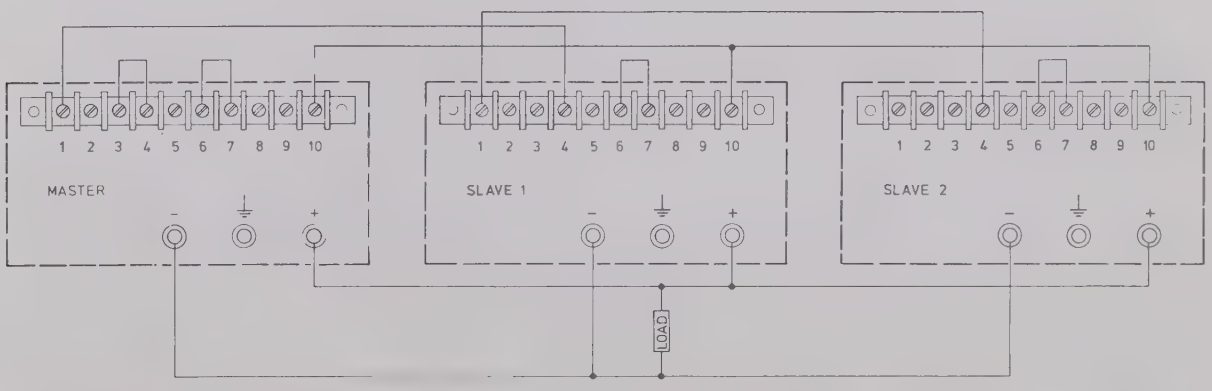



Fig. 10g
Serie connection according to the "Master Slave" system




MA 8127

Fig. 10h
Parallel connection according to the "Master Slave" system

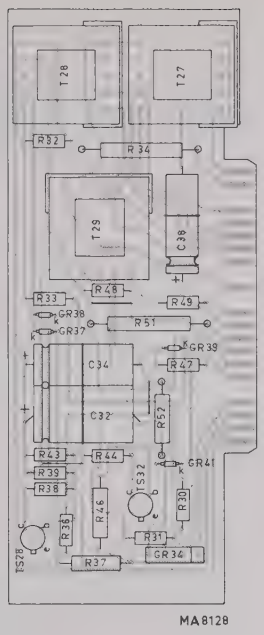

T28
T27
R32
R34
T29
C38
R48
R49
R33
GR38
GR37
R51
GR39
C34
R47
C32
R52
R43
R44
S32
GR41
R39
R38
R46
R30
R38
R31
TS78
R37
GR34
MA8128

Fig. 11

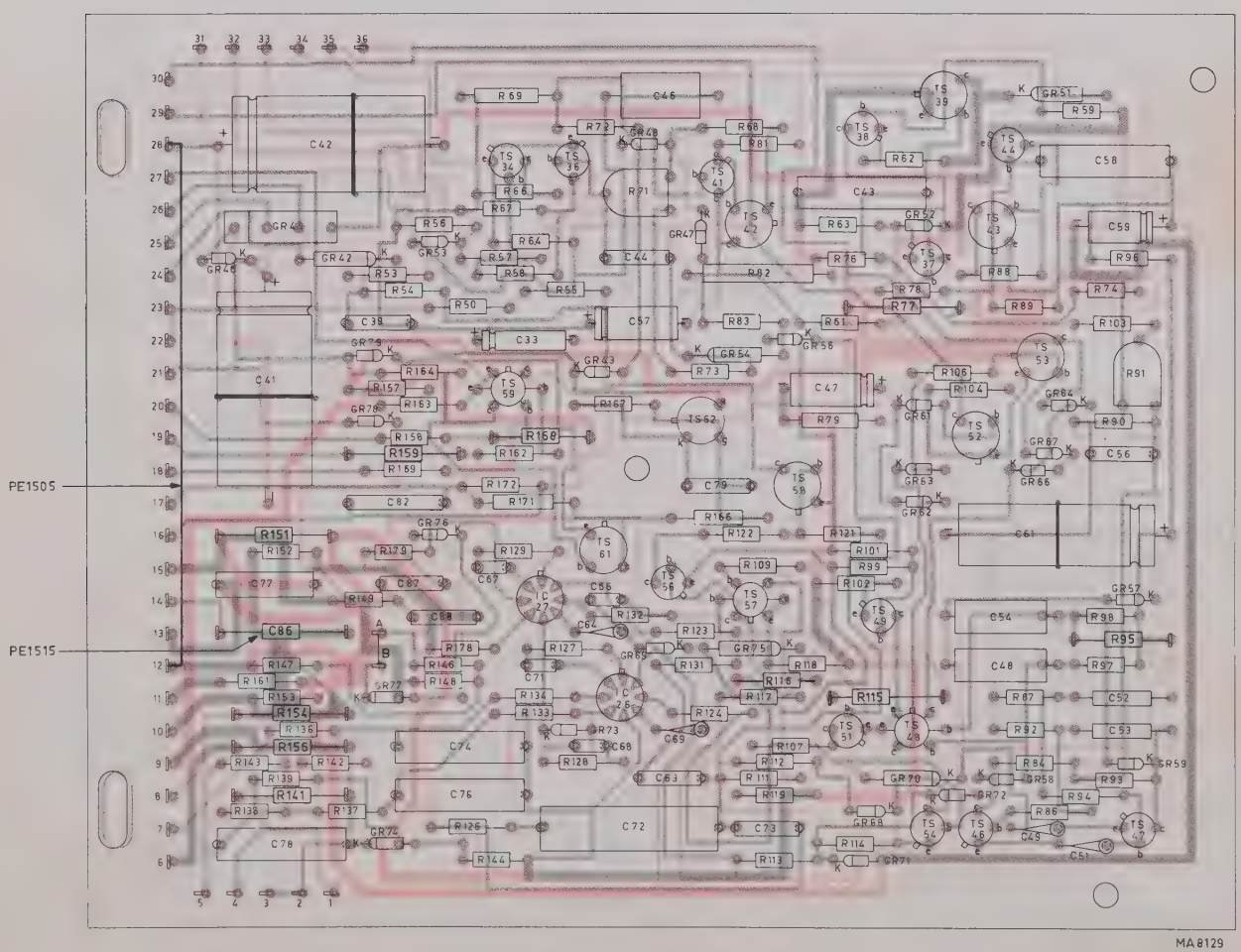

PE1505
PE1515
MA8129

Fig. 12

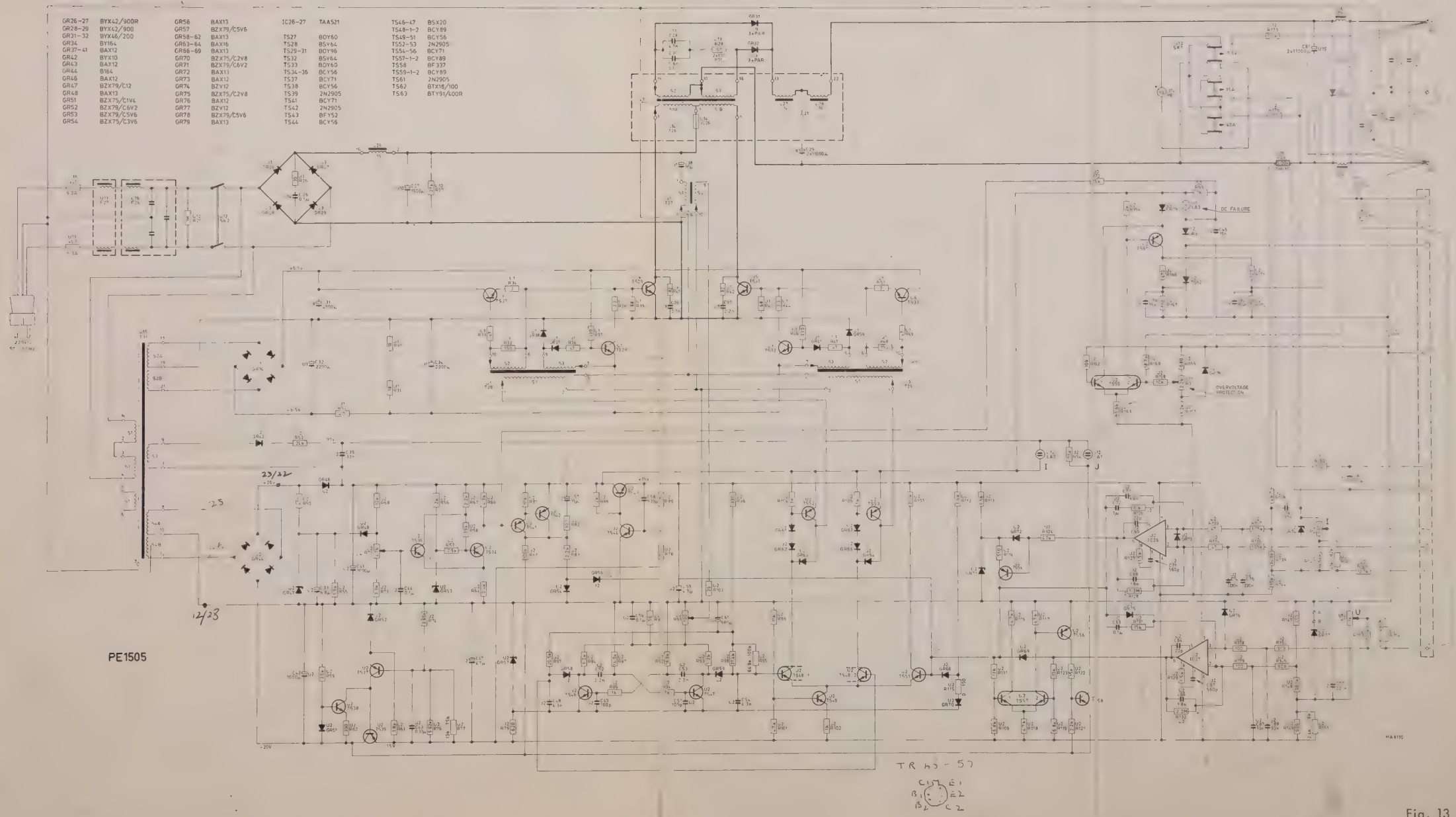

GR26-27 BYX42/900R
GR28-29 BYX42/900
GR31-32 BYX46/200
GR34 BY164
GR37-41 BAX12
GR42 BYX10
GR43 BAX12
GR44 BY164
GR46 BAX12
GR47 BZX79/C12
GR48 BAX13
GR51 BZX75/C1V4
GR52 BZX79/C6V2
GR53 BZX79/C5V6
GR54 BZX75/C3V6
GR56 BAX13
GR57 BZX79/C5V6
GR58-62 BAX13
GR63-64 BAX16
GR66-69 BAX13
GR70 BZX75/C2V8
GR71 BZX79/C6V2
GR72 BAX13
GR73 BAX12
GR74 BZV12
GR75 BZX75/C2V8
GR76 BAX12
GR77 BZV12
GR78 BZX79/C5V6
GR79 BAX13
IC26-27 TAA521
TS27 BDY60
TS28 BSV64
TS29-31 BDY96
TS32 BSV64
TS33 BDY60
TS34-36 BCY56
TS37 BCY71
TS38 BCY56
TS39 2N2905
TS41 BCY71
TS42 2N2905
TS43 BFY52
TS44 BCY56
TS46-47 BSX20
TS48-1-2 BCY89
TS49-51 BCY56
TS52-53 2N2905
TS54-56 BCY71
TS57-1-2 BCY89
TS58 BF337
TS59-1-2 BCY89
TS61 2N2905
TS62 BTX18/100
TS63 BTY91/400R
DC FAILURE
OVERVOLTAGE PROTECTION
PE1505
TR 53 - 57

Fig. 13

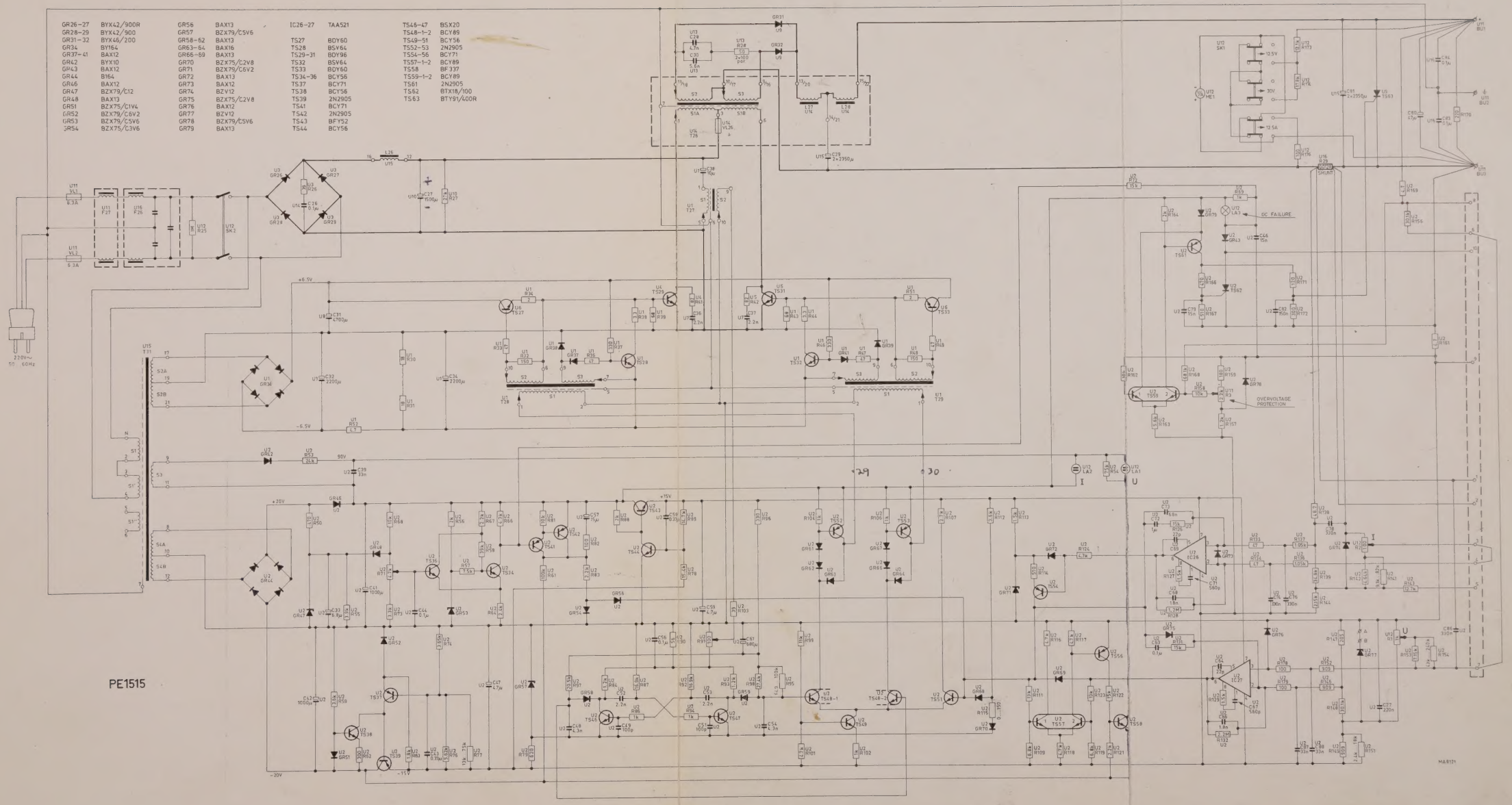

GR26–27 BYX42/900R
GR28–29 BYX42/900
GR31–32 BYX46/200
GR34 BY164
GR37–41 BAX12
GR42 BYX10
GR43 BAX12
GR44 BI64
GR46 BAX12
GR47 BZX79/C12
GR48 BAX13
GR51 BZX75/C1V4
GR52 BZX79/C6V2
GR53 BZX79/C5V6
GR54 BZX75/C3V6
GR56 BAX13
GR57 BZX79/C5V6
GR58–62 BAX13
GR63–64 BAX16
GR66–69 BAX13
GR70 BZX75/C2V8
GR71 BZX79/C6V2
GR72 BAX13
GR73 BAX12
GR74 BZV12
GR75 BZX75/C2V8
GR76 BAX12
GR77 BZV12
GR78 BZX79/C5V6
GR79 BAX13
IC26–27 TAA521
TS27 BDY60
TS28 BSV64
TS29–31 BDY96
TS32 BSV64
TS33 BDY60
TS34–36 BCY56
TS37 BCY71
TS38 BCY56
TS39 2N2905
TS41 BCY71
TS42 2N2905
TS43 BFY52
TS44 BCY56
TS46–47 BSX20
TS48–1–2 BCY89
TS49–51 BCY56
TS52–53 2N2905
TS54–56 BCY71
TS57–1–2 BCY89
TS58 BF337
TS59–1–2 BCY89
TS61 2N2905
TS62 BTX18/100
TS63 BTY91/400R
PE1515
OC FAILURE
OVERVOLTAGE PROTECTION

Fig. 14

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